Syllabus for AGRO/EMS 4077

# Environmental Soil Physics

Fall Semester

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| TU/TH 9:00 – 10:20 AM | Office hours: By appointment |
| Class location: Sturgis Hall, RM 135 | Office location: 311 Sturgis Hall |
| Credit hours: 3 | Instructor: Vinit Sehgal (vsehgal@agcenter.lsu.edu) |

## Course Description

This course covers the fundamentals of the physical soil system, i.e., soil components and their physical interactions, soil hydrologic and hydraulic characteristics, energy states in the soil system, and interactions between the soil-plant-atmosphere continuum. Dynamic processes involving water, air, heat, and chemicals in soils are covered. Special attention is given to the movement of water in soils under saturated and unsaturated conditions and their relationship with infiltration, plant-water uptake, and runoff generation processes.

## Learning Objectives

- To understand soil physical properties and measurements
- To study the basics of key hydraulic and hydrologic characteristics of soil
- To study dynamic water and energy state in soil system and its impact on soil-plant-atmospheric interactions

## Prerequisites

Prerequisite: AGRO / EMS 2051 or consent of Instructor.

## Textbooks

- Hillel, D. (2013). *Introduction to Soil Physics*. Academic press.
- Hillel, D. (2013). *Environmental Soil Physics*. Academic press.

## Tentative Timeline & Topics

| Timeline | Topic | Subtopics |
|---|---|---|
| Week 1 | Introduction and basic concepts | |
| Week 2 | Soil content and potential | • Soil moisture content<br>• Energy state of soil moisture<br>• Soil water potential<br>• Soil moisture characteristic curves |
| Week 3 | Saturated and flow in soils | • Darcy's law<br>• Specific discharge and average velocity<br>• Limitations of Darcy's law<br>• Hydraulic conductivity<br>• General saturated flow equation<br>• General equation for unsaturated flow<br>• Hydraulic diffusivity |
| Week 4 | Infiltration and runoff | • Factors affecting soil infiltrability<br>• Moisture profile distribution during infiltration<br>• Green-Ampt infiltration model |
| Week 5 | Internal drainage and redistribution | • Internal drainage through wetted profiles<br>• Redistribution in partially wetted profiles |
| Week 6-7 | Commercial and low-cost soil monitoring systems | • Commercial soil sensors and monitoring systems<br>• Build-your-own soil sensing system (moisture, temperature and humidity)<br>• Automated data logging |
| Week 8 | Mid-term exam | |
| Week 9 | Bare soil evaporation | • Physical conditions for evaporation<br>• Evaporation in the absence of water table<br>• Soil hydrologic regimes during soil evaporation |
| Week 10 | Plant water uptake | • Basics of plant-water relationship<br>• Root water uptake and transpiration<br>• Soil water availability to plants |
| Week 11 | Scaling perspective in soil physics | |
| Week 12 | Field data collection and telemetry | • Representative field sampling<br>• Digital telemetry for remote data access and analysis |
| Week 13 | Solute transport in soils | • Chemical storage and flux in soils<br>• Hydrodynamic dispersion in soils |
| Week 14 | Temperature and heat flow | • Soil heat conductance<br>• Heat capacity of soils<br>• Soil thermal regimes |
| Week 15 | Final exam | |

## Assessment

*Class participation* - The course emphasizes on class participation, which includes engaging with the peers and instructor in learning activities through (but are not limited to): Providing peer feedback, asking relevant questions during the class, engaging in class discussions, etc.

*Assignments* - Students will have 10-12 take-home assignments over the semester.

*Course Evaluation* - Class Participation (10%), Assignments (50%), Midterm exam (20%), Final exam (20%)

*Grading Scale* - Your final grade in this course will be assigned as follows:

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|---|---|---|---|---|
| A+: 100-97 | B+: 89. 9-87 | C+: 79.9-77 | D+: 69.9-67 | F: 59.9-0 |
| A: 96.9-93 | B: 86.9-83 | C: 76.9-73 | D: 66.9-63 | |
| A-: 92. 9-90 | B-: 82.9-80 | C-: 72.9-70 | D-: 62. 9-60 | |

## Homework Policy

Late submission without a valid excuse will result in a zero grade. Working together on the problem sets is encouraged. The use of online resources is allowed. However, the students must submit individual assignments with proper acknowledgments. Students must typewrite all the homework assignments and present their work professionally. The use of ChatGPT or other automatic generative AI tools is NOT permitted.

## University Policy

All academic work must meet the ethical standards of the university. Students and instructors are expected to provide a safe learning environment for all students. Students must inform themselves about those standards before performing academic work for this class.

In the event of a campus-wide closure, this course may transition to an alternative form of instruction. I will notify you by Moodle announcement as soon as possible of the format our course will take. For example, the class may be held via Microsoft Teams and recorded for those unable to attend, or I will provide a lesson online that you can do asynchronously, or we may cover content at a different pace or schedule. If the emergency closure impacts scheduled tests, I will make alternative arrangements as soon as possible. If alternative formats are not available due to widespread loss of power and/or internet or other extenuating circumstances, the University may schedule makeup days per Policy Statement 117.