SULTAN QABOOS UNIVERSITY

COURSE OUTLINE

PROGRAM: Soil Sciences

1. Course Code	SWAE4111	
2. Course Title	Hydropedology for Soil-Water-Landscape Interactions	
3. Credits	3 CR, 12 CP, 6 ECTS	
4. Pre-requisite Course(s)	Introduction to Soil & Water (SWAE2201); Elements of Hydrology (SWAE3303); Environmental Soil Physics (SWAE3311) + College Requirements CR	
5. Co-requisite Course(s)		
6. Equivalent Course(s)		
7. Incompatible Course(s)		
8. Course Category	☐ University Requirement	☐ University Elective
	☐ College Requirement	☐ College Elective
	☒ Department Requirement	☐ Department Elective
	☐ Specialization Requirement	☐ Specialization Elective
	☐ Other (specify):	
9. Course Owner	College: CAMS	Department: SWAE
10. Course Type	☐ Lecture	☒ Lecture/Lab
	☐ Lecture/Seminar	☐ Lecture/Studio
	☐ Lecture/Tutorial	☐ Lecture/Lab/Tutorial or Seminar
	☐ Tutorial	☐ Laboratory (Practical)
	☐ Field or Work Placement	☐ Studio
	☐ Seminar	☐ Internship
	☐ Workshop	☐ Project
11. Language of Instruction	English	

12. Course Description

This more advanced soil science course aims to understand the holistic and the interdependent interactions that existing between soil landscapes, pedogenesis, and hydrologic processes. The course emphasizes on the relationships among distinct soil pedogenic features (such as soil color, texture, horizontation, and heterogeneity), geomorphism of landscapes, and surficial sediments using the concept of soil catena. The course also discuss the different flow pathways (i.e. overland flow, subsurface lateral flow, groundwater flow, and vadose zone flows) exit in a typical soil catena of an arid climate and how these pathways are determined by soil characteristics. On the other hand, soils can be used as an indicator or signature of hillslope and catchment hydrological behavior. The dictation of other environmental factors (such as climate and organisms) and anthropogenic variables relevant to land use and management on the landscape water flux is also discussed. The course is divided into three modules:

(i) This first part introduces hydropedology as synergistic integration of pedology with hydrology towards a holistic study of soil-water interactions and landscape-soil-hydrology relationships. This module is organized around a series of process connections and interactions that will give a basic knowledge on the interface between hydrosphere and pedosphere. The module emphasizes flow and transport processes in soils as they occur across the landscape (hillslope to catchment zone). It covers topics such as geomorphic descriptions of soils landscapes, factors and processes involved in the genesis and distribution of pedogenic features (e.g. such as redoxmorphic features, presence of calcareous precipitates, and salic materials, etc.) along soil catenas of arid lands. Pedogenic features as indicators in soils in relation to hydrology and landscape position are also covered.

(ii) Understanding the interaction between hydrology and pedology is very important. Hydrologists may make unrealistic assumptions of homogeneity and isotropy about soils in their “sand-tank” models, and studies that clearly do not reflect real-world conditions. This part of the course focus in general on how to predict preferential flow pathways and their dynamics at different scales, their interfaces with the soil matrix, and their significance in different types of soils and landscapes.

More specifically: Where, when, and how water moves through different parts of the soil medium and its impacts on soil physical, chemical, and biological processes and subsequently spatial–temporal patterns of soil distributions and soil functions? Case studies are discussed to highlight these concepts. The impact of hydropedology on the ecosystem is also discussed with the help of published experiments and case studies.

(iii) This module gives hand-on skills in HYDRUS-1D as a computer package for practical modeling of moisture flow and solute transport in a heterogeneous vadose zone at a scale of pedon or small agricultural plot, where core data (soil samples) allow parametruization of basic hydrophysical properties. Analytical solutions to the Richards equation and advective dispersion equation are intertwined and cross-compared with results of practical modeling sessions in the Multimedia lab. Students will learn how to prepare input data, run the package and compare the numerical results with benchmark formula for two cases: a) Numerov's phreatic flow through an earth-filled Al-Khoud dam to a toe drain and b) post-rain (irrigation) redistribution of soil moisture obstructed by a subsurface lens of contrasting hydraulic-capillary properties and subject to varying evaporation boundary conditions and water uptake by plant roots. Sensitivity analysis is also illustrated. Basics of pedotransfer functions is taught in conjunction with the Rosetta package of HYDRUS

13. Teaching/Learning Strategies

When students finish the course, they will be able to:

a. Gain a holistic understanding of complex landscape-soil-water-vegetation relationships.
b. Understand and predict the complex set of processes associated with water flow through soils, including weathering, internal erosion, and movement of ions with ensued dissolution and precipitation of soil minerals.
c. Comprehend and retain the knowledge that soils are not randomly distributed across the landscape
d. Place the soil formation factors/processes in a broader geomorphological context and understand how these factors/processes overlap and interact with geomorphic processes
e. Improve knowledge and establish links between pedology, sedimentology, geomorphology, soil physics, and surface and subsurface hydrology.
f. Master basic options of HYDRUS 1D.
g. Understand how evapotranspiration and soil heterogeneity affect soil water dynamics and plant physiology; connect modeling to the holistic approach in item a) above.

The course will be graded out of 100 points. The grade assignments from the final mark will be as follow:

a. The first type of evaluation is based on three tests (1 hr. each) covering the three modules. The tests are given at the end of each module. The tests may include multiple choices questions, a single write up question, calculations, modeling exercises, etc. All together, these two tests will cover 30% towards the final mark of the course.
b. Students Debates: The students will have to select one topic/issue or problem related to pedology/hydrology/hydropedology in Oman, review the literature and gather information pertaining to that topic and then make a debate presentation. This type of making a debate group presentation will be graded based on (i) thoroughness in the understanding and critical thinking of the topic, (ii) clarity presenting of arguments, and (iii) critical thinking during the discussion (e.g. scrutinizing arguments, taking multiple perspectives, providing positive as well as negative appraisal of the topic content, etc.). This is worth of 5% towards the final mark of the course.
c. Five pop up quizzes will be given and these will worth 5% out of the total mark of the course.
d. There will be 3 computer group assignments and a column experiment setting up that will worth 10% of the total mark of the course.
e. A 3 hrs. comprehensive final exam incorporating all topics covered in all three modules. This is worth of 45% towards the final mark of the course.

14. Assessment Components and Weight [%]

☒ Quizzes 5	☒ Practical 15	☒ Other (specify): Studnets debates 5
☐ Homework assignments	☐ Project	
☒ In-term examination(s) 30	☒ Final examination 45	

15. Grading Method

☒ A-F Scale ☐ Pass/Not passed

16. Textbook(s) and Supplemental Material

Main Reference

Advances in hydropedology. 2005. Lin, H., Bouma, J., Wilding, L. P., Richardson, J. L., Kutilek, M., & Nielsen, D. R. Advances in Agronomy, 85, 1-89.

Supplemental Materials:

- Handbook of soil science. 1999. Sumner, M. E. (Ed.). CRC press.
- Soils and Geomorphology.1999. Third Edition. Birkeland P. W. Copyright © Oxford Univ. Press, New York.
- Radcliffe, D.E. and Simunek, J., 2010. Soil physics with HYDRUS: Modeling and applications. CRC Press/Taylor & Francis.
- Selected published papers that will be distributed along the semester.

17. Matching Course Objectives with Program Outcomes and SQU Graduate Attributes

SQU Graduate Attributes

A. SQU graduates should be able to:	**B. SQU graduates possess**	**C. SQU graduates should**
1. apply the knowledge and skills relevant to the specialization 2. communicate effectively and use information and communication technologies 3. critically analyze complex information and present it in simple clear manner	1. interpersonal communication skills and alignment with culture of international labour market to assist them in practical life and in living successfully 2. skills and motivation for independent learning and engagement in lifelong learning and research 3. work ethics and positive values, and intellectual independence and autonomy 4. teamwork skills and display potential leadership qualities	relish good citizenship qualities, be conscious of their national identity and be socially responsible, engage in community affairs and be mindful of contemporary issues.

#	Intended Student Learning Outcome /Course Learning Objective	Relevant Program Outcome(s)	Applicable Attribute(s)
1.	Integrate the pedological and hydrologic concepts gained from this course in projects relevant to soil-water-landscape relationships such as those involve contaminant transport and fate in the environment, water and soil quality, watershed processes and management, and terrestrial ecosystem functions.	Demonstrate proficiency in application of soil sciences principles in real world problems	ABET: a3
2.	Understand the flow patterns as a function of pedological aspects and its effect on the distribution/redistribution of the soil moisture within the soil.	Demonstrate proficiency in application of science in solving soil and water management problems.	ABET: a2
3.	Know that the relation and interaction between the hydrology and pedology is cyclic and the effect is dynamic.	Demonstrate proficiency in application of science in solving soil and water management problems.	ABET a2
4.	Use Hydrus 1D to parametruize basic hydropysical properties.	Use modeling and simulation tools in solving real world problems	ABET: k2
5.	Design column experiments for studying soil water motion of stratified soils.	Ability to design experiments by choosing appropriate testing parameters and standard procedures	ABET: b1
6.	Using critical thinking, by working in groups, in comprehending and presenting journal topics/debatic topics relevant to hydropedology across different landscapes.	Explain the role in the team in a well-defined context and bring a particular experience in solving the problem	ABET: d2
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16. Student Responsibilities

It is the student's responsibility to know and comply with all University Academic Regulations relevant to participation in this course. These regulations specifically include attendance requirement and students` academic code of conduct.

For attendance, it is the student's responsibility to be punctual and to attend all classes.

Students are expected to perform their work with honesty and avoid any academic misconduct, which is defined as the use of any dishonest or deceitful means to gain some academic advantage or benefit. This can take many forms, including but not limited to, the following: copying, plagiarism, collusion and forging documents. For full details, please refer to the Undergraduate Academic Regulations and to the Student Academic Misconduct Policy.

Additionally, this course requires that you:

Students should be aware of and abide by all University Regulations. Computer software related to the course (Hydrus) is available in the multimedia lab (AGR/239R) of the College.

COURSE INFORMATION			
Course Code	SWAE4111	**Course Title**	Hydropedology for Soil-Water-Landscape Interactions
Semester/ Year	Spring 2018	**Section(s)**	10/11
Day, Time, and Place	Monday 12:00 pm - 01:50 pm (AGR 239R) Wednesday 12:00 pm - 01:50 pm (AGR 239R)		

Course Coordinator	Said Al-Ismaily		
Office Location	247 ANX	**Office Hours**	Monday 2:30 pm – 3:30 pm & Wednesday 2:30 pm – 3:30 pm
Office Tel. Ext.	3642	**Email**	esmaily@squ.edu.om

Tentative Schedule

Week	Lecture #	Topic/Material to be covered	Assessment
1	Topic 1	Introduction & Course outline	
2	Topic 2	Hydropedology as synergistic integration of pedology with hydrology and Geomorphic descriptions of soils landscapes	
3	Topic 3	Water movement over landscape in relation to soil cover	
4	Topic 4	Morphological features as signatures of soil hydrology	
5	Topic 5	Soil Catena: holistic framework for understanding soil-water-landscape interactions	
6	Topic 6	Test I (Monday) Preferential flow in pedological perspectives (i)	15%
7	Topic 7	Preferential flow in pedological perspectives (ii)	
8	Topic 8	Small scale case studies: Water dynamics in block-design soil and in heterogeneous embankments and its effect on the ecosystem	
9	Topic 9	Selected case studies on watershed scale	
10	Topic 10	Basic models of unsaturated flow and solute transport in soils; analytical solutions and pedotransfer functions	
11	Topic 11	Basics of HYDRUS 1D software; numerical modeling of flow to a toe drain	
12	Topic 12	Test II (Monday Class) / Infiltration, evapotranspiration and soil moisture redistribution: analytical and numerical tools (i)	15%
13	Topic 13	Infiltration, evapotranspiration and soil moisture redistribution: analytical and numerical tools (ii)	
14	Topic 14	Edaphic and water factors in arid environments : effects on plant physiology and agro-engineering techniques of soil control in alleviation of water deficit and heat stress	
15	Topic 15	Students Debates (Week 14 if possible for only Spring 2018)	5%
16		Final Exam (As announced and/or updated by A&R)	45%
17			

APPENDIX A: INSTRUCTORS OF MULTIPLE SECTIONS					
Section	**Instructor**	**Day, Time, and Place**	**Office Location and Extension**	**Email**	**Office Hours**
10/11	Said S. Al-Ismaily	Monday 12:00 pm - 01:50 pm (AGR 239R) Wednesday 12:00 pm - 01:50 pm (AGR 239R)	247 Anx; Ext. 3642	esmaily@squ.edu.om	Monday 2:30 pm – 3:30 pm & Wednesday 2:30 pm – 3:30 pm
10/11	Anvar Kacimov	Sunday 12:00 pm - 01:50 pm (AGR 239R) Wednesday 12:00 pm - 01:50 pm (AGR239R)	237 Anx; Ext. 3688	anvar@squ.edu.om	Monday 2:30 am – 3:30 am & Wednesday 2:30 am – 3:30 am

APPENDIX B: ADDITIONAL INFORMATION