North South University

Department of Civil and Environmental Engineering (DCEE)

CEE 460 Groundwater Hydraulics

Course Outline

1 BASIC INFORMATION

1.1 COURSE DESCRIPTION

1.2 This course covers fundamentals of subsurface flow and transport, emphasizing the role of groundwater in the hydrologic cycle, the relation of groundwater flow to geologic structure, and the engineering applications of groundwater hydraulics. The course will cover the following topics: Darcy equation, flow nets, mass conservation, the aquifer flow equation, heterogeneity and anisotropy, storage properties, unsaturated flow, recharge, stream-aquifer interaction, well hydraulics, numerical models, and contaminant transport processes.

1.3 COURSE CONTENTS

1. Occurrence of Groundwater
2. Groundwater Movement and Unsaturated Flow
3. Well Hydraulics
4. Groundwater level and Environmental Influence
5. Contaminant transport and Groundwater quality

1.4 COURSE INFORMATION

1. Senior level undergraduate course
2. Credit hours: 3 hours of classroom contact and 6 hours of self-study per week.
3. Two classes per week having 1.5 hours of duration
4. Tutorials moderated by teaching assistants
5. The course requires knowledge on Hydrology, Fluid Mechanics and Open Channel Flow

1.5 PREREQUISITE COURSES:

1. CEE 360: Open Channel Flow

1.6 FACULTY

1. Name: Dr. Nazmun Nahar, P.Eng., Professor, DCEE, Initial: NMR
2. Room No: SAC 731/ADMN 625,
3. Phone: Office Ph: 8852000 ext. 1053
4. E-mail: nazmun.nahar@northsouth.edu
5. Office hours for summer 2019: Sunday 2 pm – 3:00 pm., Tuesday 3:00 pm – 4:00 pm.

1.7 CLASS HOURS:

- Section 1: MW 01:00 pm – 02:30 pm (Room #SAC 304)

1.8 TEXT BOOK:

1.9 Groundwater Hydrology, Todd, David Keith, Larry W. Mays, 3rd Ed., John Wiley & Sons, 2004

1.10 REFERENCE BOOKS:

1. Garg, S.K. (19th Ed., 2005). “Irrigation Engineering and Hydraulic Structures”.
2. Freeze R.A, Cherry J.A., “Groundwater”, Prentice-Hall, 1979, GB1003.2F73
3. Raghunath H.M. (2007) “Groundwater”, 3rd edition, New Age International Publishers.

2 COURSE OBJECTIVES AND OUTCOMES

2.1 COURSE OBJECTIVES:

1. To understand the fundamentals of groundwater flow, aquifer properties, porous media flow and contaminant transport.
2. To apply the principles of groundwater hydraulics in solving problems related to well hydraulics and groundwater contamination.

2.2 COURSE OUTCOMES (COs):

2.2.1 CO1: Apply the governing principles of subsurface flow and transport and continuity principles

2.2.2 CO2: Assess local subsurface geology by using the basic understanding of aquifer properties

2.2.3 CO3: Estimate hydraulic conductivity and other parameters in isotropic and anisotropic media of confined and unconfined aquifers for time varying conditions.

2.2.4 CO4: Assess different design requirements and conduct groundwater flow analysis

2.3 MAPPING OF COURSE OUTCOMES TO BSCEE PROGRAM OUTCOMES

L: Slightly maps (low); M: Moderately maps (medium); H: Substantially maps (high)

	PO - 1	PO - 2	PO - 3	PO - 4	PO - 5	PO - 6	PO - 7	PO - 8	PO - 9	PO - 10	PO - 11	PO - 12	PO - 13
CO1	H												
CO2		M											
CO3				H									
CO4					H								

2.4 CO DELIVERY AND ASSESSMENT

Course outcomes	Bloom's taxonomy, domain/level *(C: Cognitive, P: Psychomotor A: Affective)*	Delivery methods and activities	Assessment tools
CO1	C2	Lecture, video	Quiz, Assignment
CO2	C4	Lecture, group discussion	Midterm exam, paper review
CO3	C5	Lecture, field trip	Report, Final exam
CO4	C6, P2	Suggestions only	Class project

2.4.1 Cognitive domain (knowledge-based): C

1: Knowledge, 2: Comprehension, 3 Application, 4 Analysis, 5: Synthesis, 6: Evaluation

2.4.2 The affective domain (emotion-based): A

1: Receiving, .2: Responding, 3: Valuing, 4: Organizing, 5: Characterizing

2.4.3 The psychomotor domain (action-based): P

1: Perception, 2: Set, 3: Guided response, 4: Mechanism, 5: Complex overt response, 6: Adaptation, 7: Origination

3 BSCEE PROGRAM OUTCOMES (PO)

3.1.1 PO – 1: Engineering Knowledge

Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex civil engineering problems.

3.1.2 PO – 2: Problem analysis

Identify, formulate, research the literature and analyze complex civil engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

3.1.3 PO – 3: Design/development of solutions

Design solutions for complex civil engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

3.1.4 PO – 4: Investigation

Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

3.1.5 PO – 5: Modern tool usage

Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex civil engineering activities with an understanding of the limitations.

3.1.6 PO – 6: The engineer and society

Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional civil engineering practice.

3.1.7 PO – 7: Environment and sustainability

Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

3.1.8 PO – 8: Ethics

Apply ethical principles and commit to professional ethics, responsibilities and the norms of the civil engineering practice.

3.1.9 PO – 9: Individual work and teamwork

Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

3.1.10 PO – 10: Communication

Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

3.1.11 PO – 11: Project management and finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.

3.1.12 PO – 12: Life-long learning

Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

3.1.13 PO – 13: Contemporary Issues

Demonstrate sound knowledge on global and local contemporary civil engineering issues.

4 COURSE ASSESSMENT

4.1 TEACHING/LEARNING STRATEGIES

4.1.1 Lectures

- Attend all classes punctually
- Learn methods that are not precise in the textbook
- Follow worked examples taught in the class and provided in the textbook
- Solve exercises from the textbook and innovative problems in the assignments

4.1.2 Tutorials & Group work

- Contact teaching assistant whenever required
- Work with peers to solve problems, discuss with friends

4.1.3 Private study

- Review lecture material and textbook

4.2 ASSESSMENT

- Frequent quizzes will be taken to check if you are following the lectures attentively to check the basic knowledge
- In-class exams of duration around 15 minutes will be taken to check your ability in solving a problem following a certain method
- Midterm exam and final exam will contain comprehensive problems to assess complete understanding

4.3 EVALUATION:

Distribution of numerical scores		
Class attendance	5%	Over 70% -5%, below 40%- 0, in between obtained attendance % will be calculated in 5%
Quizzes	15%	4 quizzes will be taken
In-Class Assessment	5%	Declared in the same class
Midterm	20%	One and half hour
Project 1	10%	2 weeks
Final Exam	30%	One and half hour
Project 2	15%	3 weeks

4.4 GRADING POLICY:

Generally, NSU grading policy will be followed. However, minor deviation is still possible depending on the situation.

4.5 EXAM POLICY:

No makeup for quiz and in-class exam is possible. MAKE UP for MID-TERM OR FINAL EXAM WILL BE ARRANGED UNLESS AN ABSOLUTELY UNAVOIDABLE VALID REASON FOR ABSENCE IS FOUND. For such unavoidable circumstances, written explanation of the situation must be submitted before the exam. If any class test or mid-term exam cannot be held on the due date, the exam will be automatically shifted to the very next available class, unless otherwise announced.

5 LECTURE SCHEDULE

* One Day = 1.5 lecture hours, Total 22 lecture = 33 lecture hours

LECTURE SCHEDULE

Week No.	Topics	Book chapters	Assignment/quiz/Midterm/Project/Final
1	Introduction: • Definition of Groundwater hydrology and hydraulics • Source of groundwater • Utilization of groundwater • Groundwater in the Hydrologic Cycle • Hydrologic Budget	Ch - 1	Assignment #1 Quiz 1
2	Occurrence of GROUNDWATER ▪ Origin and age of water ▪ Aquifers ▪ Rock properties affecting aquifer ▪ Geologic formation as aquifers ▪ Storage coefficient ▪ Soil classification	Ch-2	Assignment #2 Quiz 2
3,4,5	Groundwater movement ▪ Darcy's Law ▪ Permeability and Hydraulic Conductivity ▪ Groundwater flow rates and directions ▪ Streamlines and Flow Nets ▪ General flow equations	Ch - 3	 Quiz 3 Midterm exam
6,7,8, 9	Well hydraulics ▪ Steady and unsteady radial flow to a well in confined, unconfined aquifer ▪ Well flow near aquifer boundaries ▪ Well development ▪ Testing well for yield ▪ Pumping equipment ▪ Slug tests	Ch -4 Ch -5	 Project 1 Quiz 4
	Unsaturated flow	Ch-3	Field trip (tentative)
	Groundwater level and environmental influence ▪ Time variation of GW levels ▪ Streamflow and GW levels ▪ Land subsidence and groundwater	Ch -6	 Project 2
9	GW quality	Ch - 7	Assignment #3
10	Contaminant Transport ▪ Advection and Dispersion ▪ Sorption and Diffusive Mass Transfer	 Ch -8	Quiz 5 Assignment #4

	▪ freshwater and saltwater interaction ▪ Aquifer Remediation	(8.8, 8.10)	
12	Miscellaneous and Review		
			FINAL EXAM

6 CODE OF CONDUCT

- It is highly requested to maintain discipline in the class like not to be late, refrain from making noise during lecture time, not to leave the class early.
- Adopting unfair means in the exams will be considered as a serious crime and the student shall be placed to the university disciplinary committee.
- All materials should be neat and clear, and demonstrate professionalism
- Direct duplication of the work of another is a big offense
- Paraphrasing another person's work with very minor changes keeping the meaning is also plagiarism