

ESC 462
Hydrogeology
3 Credits

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ESC 462 Version: 10



Hydrogeology

Calendar Description

Hydrogeology is the study of the occurrence, characterization and movement of water below the earth's surface. In this course the basic physical and chemical hydrogeologic parameters are introduced and groundwater management techniques are discussed. Lab exercises and problem sets involve describing the subsurface environment, determining the physical and chemical properties of aquifers, and characterization and modeling of groundwater flow.

Rationale

This is a required course for students in Bachelor of Applied Science: Environmental Management degree. As human impacts on water resources continue to multiply, the need for responsible water and watershed management becomes increasingly important. Groundwater on the prairies provides both subsurface freshwater supply, and contributes and maintains flow to surface water bodies. The amount of flow and rate of movement of groundwater affects the rates at which water can be pumped from the subsurface without creating significant impacts on aquifers and groundwater users. Further, the interaction of geological materials with groundwater affects the movement and transformation of pollutants in the subsurface environment. This course is fundamental to the understanding of the interrelationships between water, the subsurface environment and human requirements.

Prerequisites

SC 301 or equivalent water resources competency strongly encouraged

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to

1. explain the basic concepts of geology including rock types, formation, stratigraphy, structural features, and plate tectonics.

2. explain, differentiate and analyze the various hydrogeologic parameters used to describe aquifer materials and the subsurface environment.
3. differentiate and evaluate the geologic controls on groundwater movement.
4. evaluate various types of aquifer pump tests and contrast the circumstances limiting their use to certain hydrogeologic environments.
5. assemble data for aquifer pump tests and evaluate and interpret the aquifer pump test data.
6. assemble data from various sources to determine safe yields from pumping wells.
7. differentiate the various types of geophysical methods and evaluate geophysical data to interpret subsurface conditions.
8. assemble and differentiate the various types of chemical constituents in groundwater and demonstrate the methods used in presentation and interpretation of chemical data.
9. analyze geochemical data and hypothesize as to what could create regional geochemical patterns.
10. evaluate and characterize subsurface flow and transport patterns using computer software.
11. explain government regulation, compliance and management issues surrounding groundwater on the prairies.
12. plan a groundwater project and recommend field practices for use in the project.

Essential Employability Skills

Essential employability skills are critical for workplace success and lifelong learning. Lakeland College prepares its graduates for the workplace and lifelong learning by integrating and promoting essential employability skills development in its curricula. Each credit course offered at Lakeland College emphasizes one or more of the following five essential employability skills:

- A. **Communication Skills** that enable individuals to listen, interpret, express, and convey knowledge and ideas so that they are received and understood.
- B. **Teamwork Skills** that enable individuals to respect the thoughts and opinions of others as they work together to plan activities, meet deadlines, complete projects, and contribute to an organization's goals.
- C. **Critical Thinking Skills** that enable individuals to conceptualize and analyze issues from various perspectives while rationally evaluating the strengths and limitations of each perspective and deciding what action to take.
- D. **Adaptability Skills** that enable individuals to respond quickly, willingly, and positively to new conditions and changing times.
- E. **Positive Attitude and Behavioural Skills** that enable individuals to be confident about themselves and to deal with people, problems, and situations with honesty, integrity, and personal ethics.

Please refer to the Knowledge/Skills Matrix of this course outline to review the essential employability skills emphasized in this course.

Resource Materials

Required Text:

None

Reference Texts:

Brassington, R. 2007. Field Hydrogeology. John Wiley and Sons. 264 p.

Domenico, F., and F. Schwartz. 1998. Physical and Chemical Hydrogeology. John Wiley and Sons. 506 p.

Fetter, C.W. 2001. Applied Hydrogeology. 4th ed. Prentice Hall Inc. 598 p.

Fetter, C.W. 1999. Contaminant Hydrogeology. 2nd ed. Prentice Hall Inc. 499 p.

Fitts, R. 2013. Groundwater Science. 2nd ed. Academic Press. 672 p.

Milsom, J. 2003. Field Geophysics. John Wiley and Sons. 244 p.

Sanders, L. 1998. A manual of Field Hydrogeology. Prentice Hall Inc. 381 p.

Conduct of Course

This course consists of approximately 42 hours of lecture and 28 hours of lab.

Evaluation Procedures

The final grade is an aggregate of the following components:

Course Activity	Portion of Final Mark
Midterm Lecture Exam	25%
Final Lecture Exam	25%
Assignments and Quizzes	15%
Laboratory Assignments	15%
Final Group Project	20%
TOTAL	100%

To obtain credit for this course, **all lab exercise as well as Final Project must be completed.**

Knowledge/Skills Matrix

Students apply and demonstrate their knowledge and skills to use

A. Communication Skills

A1. by listening, reading, interpreting information, and communicating effectively
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments/Goals 5, 6, 8 & 9
A2. by using written, spoken, and/or visual formats and media to communicate and meet needs of each particular audience
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
A3. by using libraries, Internet, technical publications, journals and other sources to find pertinent information
Evaluation(s)/Goal(s): Lab and in Class Assignments /Goals 5, 6, 8 & 9

B. Teamwork Skills

B1. by using interpersonal skills to create an atmosphere that maximizes the strengths of group members to accomplish tasks
Evaluation(s)/Goal(s): Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
B2. by using interpersonal skills to resolve conflict, relate to others, and assist others
Evaluation(s)/Goal(s): Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
B3. by contributing and listening to others as group determines realistic objectives, prioritizes tasks, and identifies resources and timelines
Evaluation(s)/Goal(s): Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
B4. by treating other members of the group open-mindedly and fairly
Evaluation(s)/Goal(s): Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
B5. by developing tactics/strategies to accomplish tasks
Evaluation(s)/Goal(s): Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9

C. Critical Thinking Skills

C1. by seeing critical thinking as a lifelong process of self-assessment
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
C2. by examining problems closely
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
C3. by examining beliefs, assumptions, and opinions, and weigh them against the facts
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
C4. by seeking out the truth
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
C5. by finding solutions; make decisions
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
C6. by incorporating new ideas that may not necessarily agree with previous thought on the topic
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab Assignments and in Class Assignments /Goals 5, 6, 8 & 9
C7. by seeing connections between topics and use knowledge from other disciplines to enhance reading and learning experiences
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab and in Class Assignments /Goals 5, 6, 8 & 9

D. Adaptability Skills

D1. by working independently or as part of team
Evaluation(s)/Goal(s): Exams / Goals 1-12; and in Class Assignments /Goals 5, 6, 8 & 9
D2. by carrying out multiple tasks or projects
Evaluation(s)/Goal(s): Exams / Goals 1-12; and in Class Assignments /Goals 5, 6, 8 & 9
D3. by being innovative and resourceful: identify and suggest alternative ways to get the job done
Evaluation(s)/Goal(s): Exams / Goals 1-12; and in Class Assignments /Goals 5, 6, 8 & 9
D4. by being open and respond constructively to change and uncertainty
Evaluation(s)/Goal(s): Exams / Goals 1-12; and in Class Assignments /Goals 5, 6, 8 & 9

E. Positive Attitude and Behavioural Skills

E1. by dealing with people, problems, and situations with honesty, integrity, and personal ethics
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab and in Class Assignments /Goals 5, 6, 8 & 9
E2. by showing interest, initiative, and effort
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab and in Class Assignments /Goals 5, 6, 8 & 9
E3. by affirming the need for positive solutions and encourage positive interaction and feedback
Evaluation(s)/Goal(s): Exams / Goals 1-12; Lab and in Class Assignments /Goals 5, 6, 8 & 9
E4. by balancing personal and family activities with job-related activities
Evaluation(s)/Goal(s): Lab and in Class Assignments /Goals 5, 6, 8 & 9

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Classroom and laboratory attendance is considered vital to the learning process and as significant to the students' evaluation as examinations and reports, therefore absenteeism is recorded.

- a. Students having a combination of excused and/or unexcused absence of 20 percent or higher for the scheduled course hours can be required to withdraw and would then automatically receive a "RW" (required withdrawal) for the course, regardless of any other evaluation results. (RW is a failing grade).
- b. An excused absence is one that is verified with your instructor. Verification should be prior to the absence or the next class day following the absence. Verification of the

absence may take the form of a note from your doctor/College nurse regarding illness, or a note from another instructor regarding a field trip or other activity, or authorization by your instructor following an in-person meeting. Be sure to contact your instructor and ask what they will require from you as verification of each absence. An unexcused absence is anything NOT verified by the instructor prior to the absence or the next class day following the absence.

NOTE: Any exceptions to the above attendance policy (e.g. timetable conflicts, work-related issues) must be approved in writing by the Department Chair prior to the beginning of the course.

It is the students' responsibility to know their own absentee record.

Normal hours are 8:30 a.m. to 6:30 p.m., with potential for evening courses, exams or extended field trips. Students are expected to be available for classes during these times.

Course Units/Topics

Unit 1: Introduction to Geology

The Rock Cycle
Rocks and Minerals
Plate Tectonics
Geologic Formations and Structures
Geology of Alberta
Review of Well Components and Construction
Hydrogeology and its Applications

Unit 2: Physical Properties

Properties of Water
Properties of Porous Media
Porosity and Permeability
Energy and Hydraulic Head

Unit 3: Principles of Flow

Darcy's Law and Hydraulic Conductivity
Measuring Hydraulic Conductivity
Heterogeneity and Anisotropy
Transmissivity
Conceptual Models of Confined and Unconfined Aquifers

Unit 4: Storage Properties and General Flow Equations

Storage Parameters of Aquifers
General Flow Equations for 2D and 3D Saturated and Unsaturated Flow

Unit 5: Modelling Steady and Transient Flow

Aquifers with Uniform Transmissivity
Flow Net Graphical Solutions
Unconfined Aquifers with a Horizontal Base
Transient Response of Aquifers to Pumping
Pumping Test Analysis

Unit 6: Regional Groundwater Flow

Local vs Regional Systems
Groundwater Systems on the Prairies - Consolidated and Unconsolidated Deposits
Interactions with Surface Water Bodies
Frozen Ground and Permafrost
Studying Flow Systems

Unit 7: Groundwater Chemistry and Contamination

Chemical Reactions
Mineral Dissolution and Precipitation
Aqueous - Phase Reactions
Natural Groundwater Chemistry Processes

Unit 8: Hydrogeology Field Projects

Ground Water Quality
Licenses and Approvals
Groundwater Management
Down Hole Geophysics
Common Groundwater Projects

Laboratory Schedule

There are a total of 6 laboratories. Topics will closely follow what is being taught in lecture.

Laboratory assignments will heavily incorporate using computer software to solve practical hydrogeological problems.



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