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SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE: GROUNDWATER AND WELLS

CODE NO: WTR229-4 **SEMESTER:** IV

PROGRAM: WATER RESOURCES ENGINEERING TECHNOLOGY

AUTHOR: SUBHASH C. VERMA

DATE: FEBRUARY 1992 **PREVIOUS OUTLINE** DATED: APRIL 1991

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APPROVED:  /^^^:27/9^

DEAN DATE

GROUNDWATER AND WELLS **WTR 229-4**

COURSE NAME **COURSE NO.**

TOTAL CREDIT HOURS: 6 4

PREREQUISITE(S):

I. PHILOSOPHY/GOALS:

On completion of this course, the student will have sufficient knowledge about the occurrence and movement of the ground water in the hydrologic cycle as well as the properties of water related to municipal and industrial water supplies. Well hydraulics as related to well design and testing water wells for evaluating drawdown and aquifer yield will be stressed. Methods of well construction and development, well testing and parameters affecting "he well efficiencies will be discussed.

II. STUDENT PERFORMANCE OBJECTIVES:

Upon successful completion of this course the student will develop/understand:

1. An aopreciation of the origin, occurrence and distribution of ground'.vater in the earth's crust.

2. Proper::ies and parameters of the aquifers as they relate to municipal and industrial well water supplies.

3. An introduction to Darcy's Law and its application in groundwater movement.

4. Application of the principles of hydraulics to develop theoretical relationships of discharge rate versus drawdown for wells in confined and unconfined aquifers.

5. Use of well equations, both equilibrium and non-equilibrium equations, to estimate the aquifer storage and transmission parameters as well as efficiency.

6. A thorough discussion of the principles and procedures of testing water wells for drawdown and estimating well yield.

7. Compare various well drilling techniques.

8. Select diameter of well and casing.

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II. STUDENT PERFORMANCE OBJECTIVES (CONT'D):

9. Make a sieve analysis of the aquifer material and plot particle size distribution curve.
10. Design the intake portion, i.e. screen and gravel pack.
11. Identify factors influencing the choice of method for well development.
12. Perform constant rate pumping test in the field and observe drawdown data.
13. Calculate aquifer constants viz. storage coefficient and transmissibility based on time and distance drawdown curves.
14. An understanding of the importance of chemical characteristics of water as related to its use for municipal and industrial purposes.
15. A familiarity with various methods of groundwater exploration and analysis of sand samples.
16. A clear understanding of groundwater quality parameters.
17. Design of sanitary landfill sites.
18. Collect groundwater samples.

III. TOPICS TO BE COVERED:

SEQUENCE OF TOPICS

TOPIC	NO. OF WEEKS
1. INTRODUCTION	
1.1 Definition and related disciplines	
1.2 History	
1.3 Use and significance	
1.4 Safe Yield	

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TOPIC NO. OF WEEKS

2. OCCURRENCE

- 2.1 Hydrologic Cycle
- 2.2 Groundwater Distribution
- 2.3 Types of Aquifers
- 2.4 Properties of Aquifers
- 2.5 Consolidated and Unconsolidated

3. GROUNDWATER MOVEMENT

- 3 .1 Fluid Energy/Head
- 3.2 Energy Equation
- 3.3 Darcy's Law
- 3.4 Application of Darcy's Equation
- 3.5 Hydrostatics
- 3.5 Steady Vertical Flow
- 3.7 Permeameters

4. WELL HYDRAULICS

- 4.1 Definitions of Terms
- 4.2 Equilibrium Well Formulas
- 4.3 Determining Aquifer Permeability
- 4.4 Relation of Drawdown to Yield
- 4.5 Introduction to Non-Equilibrium Formula
- 4.5 Time drawdown curves
- 4.7 Well efficiency

5. WELL DRILLING

- 5.1 Cable-tool percussion method
- 5.2 Hydraulic rotary drilling
- 5.3 Reverse rotary drilling
- 5.4 Driven wells

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TOPIC NO. OF WEEKS

.-JLYZING SAND SAMPLES

1 Grain Size Analysis
2 Soil Classifications
3 Particle Size Distribution Curves
4 Effective Size and Uniformity Coefficient

7. WATER-WELL DESIGN

7.1 Selection of casing size
7.2 Well screen design
7.3 Gravel-pack design
7.4 Sanitary protection
7.5 Factors affecting well efficiency

8. WELL DEVELOPMENT

8.1 Mechanical surging
8.2 Hydraulic surging
8.3 Overpumping and backwashing

9. TESTING WATER WELLS

9.1 Definition of Terms
9.2 Measuring Pumping Rates
9.3 Water Level Measurements
9.4 Aquifer Test Data
9.5 Estimating Well Yield
9.6 Type of pump tests
9.7 Theoretical formulations
9.8 Well efficiency

10. CHEMICAL CHARACTER OF GROUNDWATER

10.1 Chemical Properties
10.2 Water Quality
10.3 Groundwater Pollution
10.4 Sanitary landfill
10.5 Groundwater Sampling

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EVALUATION METHODS: (INCLUDES ASSIGNMENTS, ATTENDANCE REQUIREMENTS ETC.)

Final mark in the course will be based c r.

Unit Test I	20%
Unit Test II	20%
Final Test	40%
Lab Experiments and Exercises	20%

GRADING:

A+ = 90-100
A - 80-89%
B = 70-79%
C = 50-69%

NOTE: The above distribution is subject to change

To secure a **passing** grade, a student must score greater **than equal to 60%.**

VI, REQUIRED STUDENT RESOURCES:

Johnson Division, Groundwater and Wells, Johnson Division, UOP Inc., St. Paul, Minnesota, 19 85.

Verma, S.C., Course Manual, Sault College

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VI. ADDITIONAL RESOURCE MATERIALS AVAILABLE IN THE COLLEGE LIBRARY BOOK SECTION:

Hammer, Mark J. and K. A. MacKichan, Hydrology and Quali~/ of Water Resources, John Wiley and Sons, Inc. Toronto, 1981.

Todd, D. K., Groundwater Hydrology, John Wiley & Sons, Inc., New York, 1980.

American Water Works Association, Ground Water, Manual M21, AvWA, 6665 West Quincy Avenue, Denver, Colorado 80235.

Roscoe Moss Company, Handbook of Ground Water Development, John Wiley Interscience.

VII. SPECIAL NOTES:

Students with special needs (e.g. physical limitations, visual impairments, hearing impairments, learning dinabiliuiesi are encouraged to discuss required accommodations confidentially with the instructor.

Your instructor reserves the right to modify che course as he/she p deems necessary to meet the needs of students.