

HWRM-102 FUNDAMENTALS OF GROUNDWATER HYDROLOGY (THEORY) (02 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will introduce the basic concepts of ground water and soil properties to the students.
- The students will learn about the occurrences and movement of the ground water
- They will have the knowledge about well hydraulics and well construction techniques
- They will become conversant with different aspects of ground water quality

CONTENTS

This course is designed to provide fundamentals of groundwater, aquifer, and groundwater flow system, groundwater movement, well hydraulics, flow nets groundwater flow construction of wells as well as ground water quality.

THEORY

Unit I: Introduction:

- 1.1 Basic concepts of Ground Water and Soil water
- 1.2 Types of subsurface water, Water Potential
- 1.3 Aquifer types, Soil water movement and Ground water movement
- 1.4 Forms and origins of Ground water
- 1.5 Aquifer functions, Porosity, Storage coefficient
- 1.6 Hydraulic conductivity, transmissivity

Unit II: Occurrence of Groundwater:

- 2.1. Origin & Age of GW
- 2.2. Vertical Distribution of groundwater
- 2.3. Zone of aeration, Zone of saturation
- 2.4. GW in Hydrologic Cycle.

Unit III: Ground Water Movement:

- 3.1. Darcy's Law and its applications
- 3.2. Observation wells, Piezometers
- 3.3. Flow nets, Streamlines
- 3.4. Equipotential lines
- 3.5. Steady and non-steady flow

Unit IV: Well Hydraulics:

- 4.1. Steady flow in confined and un-confined aquifers,
- 4.2. Steady flow in confined with uniform recharge
- 4.3. Unsteady flow in un-confined aquifer
- 4.4. Wells near aquifer boundaries
- 4.5. Multiple well system
- 4.6. Specific capacity, well losses
- 4.7. well efficiency and aquifer testing

Unit V: Construction of Water Wells:

- 5.1. Well drilling methods
- 5.2. Selecting and setting of screens, design and placing of gravel pack
- 5.3. methods of well development
- 5.4. Tube well performance tests

Unit VI- Quality of Ground Water:

- 6.1. Natural GW Quality, Sources of salts

- 6.2. Measures of water quality,
- 6.3. Analysis of water quality
- 6.4. Water quality criteria
- 6.5. Saline Groundwater.

TEACHING – LEARNING STRATEGIES

- Lecture based examination
- Presentation/seminars
- Class discussion
- Quizzes

ASSIGNMENTS – TYPE AND NUMBER WITH CALENDAR

It is continuous assessment. The weightage of Assignments will be 25% before and after midterm assessment. It includes:

- classroom participation,
- attendance, assignments and presentation,
- homework
- attitude and behavior,
- hands-on-activities,
- short tests, quizzes etc.

ASSESSMENT AND EXAMINATIONS:

Sr. No.	Elements	Weightage	Details
1.	Mid Term Assessment	35%	It takes place at the mid-point of the semester
2.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentation, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

RECOMMENDED TEXT BOOKS / SUGGESTED READINGS

1. Guthrie, M., (2018) *Ground and Surface Water Hydrology*, Larsen and Keller Education ISBN-13: 978-1635496949.
2. Mandel, S., (2012). *Groundwater Resources: Investigation and Development*. Elsevier, ISBN 0323157823, 9780323157827
3. Agarwal. V. C., (2012). *Groundwater Hydrology*. PHI Learning Pvt. Ltd. ISBN 812034619X, 9788120346192
4. Karamouz, M Ahmadi,A, Akhbari. A., (2011). *Groundwater Hydrology: Engineering, Planning, and Management*. CRC Press. ISBN 1439891214, 9781439891216.
5. Todd, D.K. and Mays, L. W. (2005). *Groundwater Hydrology*. 3rd ed., Hoboken: John Wiley & Sons.

HWRM-102 FUNDAMENTAL OF GROUNDWATER HYDROLOGY (LAB) (01 Credit hrs)

PRE-REQUISITE: F.Sc. or equivalent

LEARNING OUTCOMES:

- This course will provide an introduction to the sieve analysis of soil as well as hydraulic conductivity test.
- Students will learn how to find out the texture of soil.
- The students will practice on flow net problems
- They will have the knowledge about the principles of working of as well as design of observation wells.
- The students will get used to the application of computer software for solution of ground water problems.

CONTENTS

This course provides fundamentals of groundwater, assessment of soil moisture, estimation of hydraulic properties of soil, practical examples of flow nets as well as design and operation of observation wells.

PRACTICAL

Unit 1

- 1.1 Water level measurements using different techniques

Unit II:

- 2.1 Determination of hydraulic properties of aquifers.

Unit III:

- 3.1 Determination of groundwater flow rates

Unit IV:

- 4.1 Determination of groundwater flow directions using flow nets

Unit V:

- 5.1 Determination of soil moisture contents

Unit VI:

- 1.1 Demonstration of ground water computer models

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 6. Todd, D.K., and Mays, L.W., (2008), *Groundwater Hydrology*, 3rd edition, Wiley.
 7. McWhorter, D.B., and Sunada, D.K., (2010), *Ground-Water Hydrology and Hydraulics*, Water Resources Pubns; Reprint edition.
 8. Rushton, K.R., (2003), *Groundwater Hydrology: Conceptual and Computational Models*, 1st Edition, Wiley.
- Sterrett, R.J., Edited (2007), *Groundwater and Wells*, 3rd Edition, Smyth Co Inc.