

## **HWRM-202 GROUNDWATER DEVELOPMENT AND EXPLORATION (THEORY) (02 Credit hrs)**

**PRE-REQUISITE:** HWRM-102 Fundamentals of Groundwater Hydrology

### **LEARNING OUTCOMES**

- This course will provide practical demonstrations on Reconnaissance survey and geological mapping
- The students will learn about the practical applications of Subsurface Investigation for water resources development
- They will learn how to set water wells, construction and their performance

### **CONTENTS**

This course provides an introduction to understanding of groundwater development and investigation techniques.

#### **Unit-I Introduction**

- 1.1. Groundwater facts & Historical Background
- 1.2. Recent Developments in Groundwater
- 1.3. Groundwater in Hydrologic Cycle
- 1.4. Hydrologic Budget
- 1.5. Groundwater Resources and use in Pakistan

#### **Unit-II Groundwater Occurrence**

- 2.1. Origin and Age of Groundwater
- 2.2. Water Zones below the surface
- 2.3. Soil Moisture & Soil Water
- 2.4. Zone's properties and their relationship
- 2.5. Measurement of water content

#### **Unit-III Groundwater Flow**

- 3.1. Water Flow in soils and rocks
- 3.2. Permeability, Intrinsic permeability concepts
- 3.3. Hydraulic Conductivity
- 3.4. Determination of Hydraulic Conductivity
- 3.5. Pumping and Slug Test

#### **Unit-IV Groundwater Development**

- 4.1. Groundwater Development and Surveying
- 4.2. Construction of abstraction system
- 4.3. Groundwater resources historical developments
- 4.4. Groundwater use, advantages, and limitations
- 4.5. Problems of GW Development in Pakistan
- 4.6. Problems of GW Management

#### **Unit-V Investigation of Groundwater**

- 5.1. Geophysical methods of GW development
- 5.2. Electrical Resistivity method
- 5.3. Gravity Geophysical method
- 5.4. Electromagnetic method
- 5.5. Geothermal and Seismic methods

#### **Unit-V Water Well Design & Construction**

- 6.1 Stages of Well Design
- 6.2 Drilling Methods
- 6.3 Drilling Fluids
- 6.4 Well Logging
- 6.5 Well Development Techniques

#### **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. Mandel, S. (2012). *Groundwater Resources: Investigation and Development*. Elsevier, ISBN 0323157823, 9780323157827
2. Kresic, N., (2009). *Groundwater Resources: Sustainability, Management, and Restoration*. McGraw Hill, ISBN-10: 0071492739 | ISBN-13: 978-0071492737
3. Todd, D.K. and Mays, L. W. (2005). *Groundwater Hydrology*. 3<sup>rd</sup> ed., Hoboken: John Wiley & Sons.

**HWRM-202 GROUNDWATER DEVELOPMENT AND EXPLORATION (LAB) (01 Credit hr)**

**PRE-REQUISITE:** HYD-106 Fundamentals of Groundwater Hydrology

**LEARNING OUTCOMES**

- This course will provide practical demonstrations on Interpretation geological maps
- The students will learn about the practical applications of Subsurface Investigation for water resources development
- They will learn how to set Pumping wells, construction and their performance

**CONTENTS**

This course provides an introduction to understanding of groundwater development and investigation techniques.

**PRACTICAL**

**Unit-I**

- 1.1. Water Table Contouring

**Unit-II**

- 2.1. Interpretation of Geological Maps

**Unit-III**

- 3.1. Aquifer Testing: General and Theis Solution

**Unit-IV**

- 4.1. Aquifer Testing: Diagnostic plots and Cooper Jacob solution

**Unit-V**

- 5.1 Aquifer Testing: Cooper Jacob solution II & III

**Unit-VI**

- 6.1 Well Logging Techniques and their use

**TEACHING – LEARNING STRATEGIES**

- Lecture based examination
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- Class discussion
- Quizzes

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