GROUND WATER DEVELOPMENT AND TUBE WELL TECHNOLOGY

ENAE 352

Lecture	**: 3**	**Year : III**
Tutorial	**: 1**	**Part : II**
Practical	**: 3/2**	

Course Objectives:

The objective of this course is to provide concepts of groundwater occurrence, movement, and storage, and to analyze aquifer characteristics and groundwater flow behavior. Students will be able to design tube-wells using hydrogeological and grain size data, conduct pumping tests to determine aquifer parameters, and select appropriate drilling methods, well screens, and pumps. They will also evaluate environmental impacts and apply GIS, geophysical surveys, and digital tools for sustainable groundwater development.

1 Occurrence and Movement of Groundwater (4 hours)

- 1.1 Groundwater scenario: Global and Nepali context
- 1.2 Occurrence of ground water
- 1.3 Types of water bearing formation and their characteristics
- 1.4 Ground water movement and Darcy's law
- 1.5 Acquifer characteristics influencing ground water yield
- 1.6 Permeability and factors affecting permeability
- 1.7 Measurement of permeability

2 Well Hydraulics (5 hours)

- 2.1 Classification of wells
- 2.2 Steady state flow in fully penetrating wells
- 2.3 Unsteady state flow in fully penetrating wells
- 2.4 Steady and transient state flow in partially penetrating wells
- 2.5 Interference of wells
- 2.6 Pumping test and determination of aquifer parameters by: Theis method, Coopper-Jacob method, Chow's method
- 2.7 Introduction to groundwater modeling

3 Ground Water Exploration (3 hours)

- 3.1 Objectives of ground water exploration
- 3.2 Methods of ground water exploration
  - 3.2.1 Geological method
  - 3.2.2 Geophysical methods

3.2.3 Electrical resistivity method
3.2.4 Seismic refraction method
3.2.5 Remote sensing and GIS applications
3.2.6 Water winching

4 Well Classification and Design (5 hours)

4.1 Classification of wells and tube-wells
4.2 Classification and selection of strainers
4.3 Design considerations in open wells
4.4 Test drilling
4.5 Design considerations in tube-wells
4.5.1 Preparation of bore log and its interpretation
4.5.2 Grain size distribution of water bearing strata
4.5.3 Determination of safe and sustainable yield
4.5.4 Diameter and depth of casing pipe
4.5.5 Diameter and depth of strainer
4.5.6 Design of gravel packing
4.6 Well development
4.7 Multiple well system

5 Tube-well Construction and Operation (5 hours)

5.1 Methods of drilling
5.1.1 Percussion drilling
5.1.2 Hydraulic rotary
5.1.3 Reverse rotary
5.1.4 Bamboo shallow wells
5.2 Choice of well drilling method
5.3 Design of shallow tube well and deep tube-well
5.4 Installation of well casing and screens
5.5 Operation and maintenance of tube-wells

6 Environmental Impacts on Groundwater (2 hours)

6.1 Temporal variation of groundwater, stream flows groundwater levels
6.2 Evapotranspirative and tidal fluctuations, urbanization, earthquakes
6.3 External loads, land subsidence and over extraction
6.4 Managed aquifer recharge

7 Positive Displacement Pumps (9 hours)

7.1 Reciprocating pump: Working principle; Design considerations; Operating characteristic curves; Selection and installation; Maintenance and trouble-shooting of pumps

7.2 Propeller pump: Working principle; Selection and installation; Maintenance and trouble-shooting of pumps
7.3 Hydraulic ram

8 Rotodynamic Pumps (8 hours)

8.1 Centrifugal pump: Working principle; Classification; Design considerations; Operating characteristic curves; Selection and installation; Maintenance and trouble-shooting of pumps
8.2 Turbine and submersible pump: Working principle; Selection and installation; Maintenance and trouble-shooting of pumps

9 Design Considerations of Pumping Plant (4 hours)

9.1 Design considerations in pumping plant
9.2 Pump selection based on total dynamic head
9.3 Economic analysis and ground water utilization

Tutorial (15 hours)

1. Numerical problems on Darcy's law and groundwater flow calculations
2. Computation of aquifer parameters including transmissivity and storage coefficient from pumping test data
3. Analysis of pumping test data and calculation of drawdown in confined and unconfined aquifers
4. Design and analysis problems on gravel pack, safe yield estimation, pump selection, and pump efficiency evaluation

Practical (22.5 hours)

1. Use of resistivity meter for exploration of water bearing formation
2. Measurement of ground water level and preparation of water table contour maps
3. Well log assessment
4. Analysis of aquifer material and design of gravel pack
5. Evaluation of discharge - Drawdown relationship of wells and determination of recuperation rate
6. Evaluation of aquifer parameters by pumping tests
7. Testing of well screen
8. Performance evaluation of reciprocating pumps
9. Performance evaluation of centrifugal pumps

Visit to a nearby tube-well drilling site and study of different drilling equipment.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Mark distribution*
1	4	5
2	5	8
3	3	4
4	5	6
5	5	4
6	2	4
7	9	13
8	8	12
9	4	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Todd, D.K., Mays, L.W. (2005). Groundwater hydrology. John Wiley & Sons.
2. Raghunath, H. M. (2007). Ground water. New Age International Publishers.
3. Karanth, K. R. (2007). Ground water assessment, development and management. Tata McGraw-Hill Education.
4. Michael, A. M., Khepar, S. D. (2008). Water wells and pump engineering. Tata McGraw-Hill Education.
5. Lal, J. (2009). Hydraulic machines. Metropolitan Book Co.