HWRM 403 GROUNDWATER MODELING (THEORY) (02 Credit hrs)

PRE-REQUISITE: HWRM-102

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about damental Concepts of Ground Water Modeling
- Student will learn about Steady and Unsteady Flow of Ground Water
- Student will learn about Ground Water Modeling Structure its Types
- Student will learn about Transient Flow
- Student will learn about Solute Transport Modeling

CONTENTS

Groundwater Modeling, Flow Modelling, Salute transport Modelling, Numerical Models, Transient Models, Flow nets.

THEORY

Unit-1 Fundamental Concepts of Ground Water Modeling

1.1. Basic concepts of groundwater modeling
1.2. Systems analysis and Models
1.3. Equations of numerical methods
1.4. Governing equations of ground water modeling
1.5. Derivation of governing equations

Unit-II Steady and Unsteady Flow of Ground Water

2.1. Steady state ground water flow
2.2. Unsteady state ground water flow
2.3. Solution methods for groundwater modeling.
2.4. Regional groundwater flow

Unit-III: Ground Water Modeling Structure its Types

3.1. The conceptual model and grid design
3.2. Types of ground water models
3.3. Ground water modeling layers
3.4. Types of grids
3.5. Data needs for ground water modeling
3.6. Assigning parameter values, types of boundaries,
3.7. Simulation boundaries, sources and sinks: injection and pumping wells
3.8. Finite difference models
3.9. Finite element models

Unit-IV: Transient Flow

4.1. Transient simulating

4.2. Model execution and the calibration process
4.3. Contaminant Transport
4.4. Advection, Dispersion & Diffusion, Adsorption, Boundary conditions

Unit-V: Solute Transport Modeling

5.1. Solute Transport Modeling,
5.2. Transport Models
5.3. Solution methods
5.4. Sequence of running of transport models
5.5. Limitations of models

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. Anderson, M.P & Woessner. W. W. (2015) Applied *Groundwater Modeling*. Second Edition. Elsevier Inc.
2. Jani, J. (2011). *A GIS-based Method for Groundwater Modelling*. University of Sheffield.
3. Howard S. W, Simon A. M. and Li. X. (2010). *Groundwater Modelling in Arid and Semi-Arid Areas*. Cambridge University Press.
4. Wang, H.F and Anderson, M.P. (1995) *Introduction to Groundwater Modeling*. AP Academic Press, Inc.
5. Todd, D.K., and Mays, L.W., (2008) *Groundwater Hydrology*, 3rd edition, Wiley.

HWRM 403 GROUNDWATER MODELING (LAB) (01 credit hr)

PRE-REQUISITE: HWRM-102

LEARNING OUTCOMES

Following are the learning outcomes of the course:

- Student will learn about Ground Water Modeling
- Student will learn about Development of Steady and Transient Flow
- Student will learn about Practical Performance of Ground Water Models

CONTENTS

PRACTICAL

Unit-1 Ground Water Modeling

1.1. Introduction to Groundwater Modeling Code (MODFLOW)
1.2. Introduction to different Groundwater Modeling Software's. and its GUI's

Unit-II Development of Steady and Transient Flow

2.1. Development of a Steady state groundwater flow model.
2.2. Development of a Transient groundwater flow model.

Unit-III: Practical Performance of Ground Water Models

3.1. Practical performance of MODEFLOW
3.2. Practical Performance of MT3DMS

TEACHING – LEARNING STRATEGIES

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

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