Kingdom of Saudi Arabia Ministry of Higher Education Qassim University College of Engineering		المملكة العربية السعودية وزارة التعليم العالي جامعة القصيم كليه الهندسه

CE 637 Applied Groundwater Flow Modeling

College: Engineering

Department: Civil

First: Course Definition

1- Course Code: CE 637

2- Units: 3

3- Semester:

4- Prerequisite: CE634

5- Co-requisite:

6- Location (if not on main Campus):

Second: Course Objectives

1- To develop an understanding *of of the principles governing groundwater flow.*
2- Know how to create a groundwater model using numerical and analytical solution methods.
3- To use MODFLOW to develop different types of groundwater models and be able to calibrate flow and transport models to observed field data.

Third: Course Specifications

1- Topics to be covered

Subject	No of Weeks	Units
Introduction to the principles of modeling groundwater flow systems	1	3
Finite-difference and analytic-element methods	3	9
Spreadsheet models	2	6
Boundary conditions	1	3
Calibration, sensitivity analysis, parameter estimation, particle tracking, and post-audit analysis	3	9
Application of MODFLOW to regional flow-system analysis	2	6

Computer laboratory emphasizes assigned problems that illustrate topics discussed in the course.	2	6

2- Course components (Total hrs in the Semester): 42

Lecture	Exercise	Other
42	-	0

3- Intended Learning Outcomes of the Course (ILO's)

a. *Knowledge*

i) Description of the knowledge to be acquired:

- Finite-difference and analytic-element modeling methods.
- *Steady and unsteady groundwater flow problems*
- Spreadsheet models
- Boundary conditions
- Calibration, sensitivity analysis, parameter estimation, particle tracking, and post-audit analysis
- Application of MODFLOW to regional flow-system analysis.

ii) Teaching strategies to be used to develop that knowledge

- Class lectures.
- Term projects.
- Students' presentations.
- Group discussion.
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iii) Methods of assessment of knowledge acquired

- Exams.
- Quizzes.
- Homework assignments.
- Term projects.

b- Cognitive (Intellectual) Skills

i) Cognitive skills to be developed

- Develop an understanding of the principles of modeling groundwater flow systems
- *Develop an understanding of* Calibration of groundwater flow models.
- Develop an understanding of performing sensitivity analysis.

ii) Teaching strategies to be used to develop these cognitive skills

- Class lectures.
- Case studies analysis.
- Term projects.

iii) Methods of assessment of students' cognitive skills

- Students' seminars and presentations.
- Term projects.
- Written reports.

c. Interpersonal Skills and Responsibility

i) Description of the interpersonal skills and capacity to carry responsibility to be developed

- Decision making based on engineering analysis.
- Communication skills.
- Team work.

ii) Teaching strategies to be used to develop these skills

- Class lectures.
- Term projects.
- Case studies analysis.

iii) Methods of assessment of students' interpersonal skills and capacity to carry responsibility

- Term project.
- Written reports.
- Students' seminars and presentations.

d. Communication, Information Technology and Numerical Skills

i) Description of the skills to be developed in this domain

- Literature research.
- Problems modeling.
- Utilization of computer applications in analysis and design.

ii) Teaching strategies to be used to develop these skills

- Class lectures.
- Case studies analysis.
- Computer lab sessions.
- Term projects.

iii) Methods of assessment of students numerical and communication skills

- Term projects.
- Written reports.
- Students' seminars and presentations.

e. Psychomotor (if applicable) & Other Non-cognitive Skills

i) Description of the psychomotor or other skills to be developed and the level of performance required

- NA
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ii) Teaching strategies to be used to develop these skills-

- NA
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iii) Methods of assessment of student's psychomotor skills

- NA
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4- Student Assessment Schedule

Serial	*Assessment tool (test, group project, examination etc.)*	*Week due*	*Weight*
1	Term Project – 1	3rd	15 %
2	Mid Term Exam -1	7th	15 %
3	Term Project – 2	10th	15 %
4	Term Project – 3	13th	15 %
5	Final Exam	16th	40 %

5- Student Support

- Providing electronic library of textbooks and scientific periodicals.
- Providing the necessary computer applications for the course.

6- Learning Resources

i) Essential Books (References)

- Bear J., and A.H.d. Cheng. "Modeling Groundwater Flow and Containment Transport: Theory and Application of Transport in Porous Media," *Springer Science & Business Media, USA, 2010.*
- Rushton, K.R. "Groundwater Hydrology: Conceptual and Computational Models," John Wiley and Sons, Inc, 2005, ISBN-10: 0470871660, ISBN-13: 9780470850046.

ii) Course Notes

- NA

iii) Recommended Books

- Fetter, C.W. "Applied Hydrogeology," Prentice Hall, USA, 2001, ISBN-10: 0131226878, ISBN-13: 9780131226876**.**
- Anderson, M.P., and W.W. Woessner. "*Applied Groundwater Modeling: Simulation of Flow and Advective Transport*," *Elsevier, USA, 1st edition, 1991.*

iv) Electronic Books & Web Sites:

- Scientific journals and forums.
- Instructor's instruction.

v) Periodicals

- Journal of groundwater hydrology.
- Journal of Hydrogeology.
- Journal of Hydrology.
- International Journal of Climatology.
- Journal of Environmental Economics and Management.
- ASCE scientific journals.

7- Course Evaluation and Improvement Processes

i) Strategies for Obtaining Student Feedback on Effectiveness of Teaching

- Students' questioners.

- Students' evaluation of course and instructor.

ii) Other Strategies for Evaluation of Teaching by the Instructor or by the Department

- Public faculty seminars.
- Assessment by external evaluators of students achievements.
- Instructor (Course) Report

iii) Processes for Improvement of Teaching

- Assessment of students' work by external examiners.
- Analysis of students' evaluation of course and instructor.
- Seminars by industry professionals.

iv) Processes for verifying standards of student achievement

- Check marking by an independent faculty member of a sample of student work.
- Periodic exchange and remarking of a sample of assignments/exams with a external evaluator.

v) Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.

- Assessment and evaluation of the level of achieving the course outcomes through a continuous improvement process (part of a quality assurance system established by the university),
- Consequently, actions are to be taken to improve the course delivery when necessary.
- Review of the course objectives, outcomes and curriculum every 2 years.