**The University of Jordan**

**Faculty of AgricultureDepartment of Land, Water and Environment**

**Program: 2017-2018/Second semester**

**Water Resources (0604905)**

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| --- | --- | --- | --- | --- | --- |
| **Credit hours** | 3 | **Level** | Graduate | **Pre-requisite** |  |
| **Coordinator/ Lecturer** | Dr. Michel Rahbeh | **Office number** |  | **Office phone** | 22442 |
| **Course website** | Elearning.ju.edu.jo | **E-mail** | m.rahbeh@ju.edu.jo | **Place** |  |
| **Time** | 2:00 – 3:30 pm Mon, Wed |  |  |  |  |

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| --- |
| **Office hours** |
| **Day/Time** | **Sunday** | **Monday** | **Tuesday** | **Wednesday** | **Thursday** |
| **Day** | - | \* | - | \* | - |
| **Time** | - | 11a.m. - 1 p.m. | - | 11p.m. - 1a.m. | - |

**Course Description**

In this course students will have the opportunity of using their comprehensive knowledge in hydrology and water resources for tackling issuesassociated with water resources such as impact of climate change on water resources and irrigation practices, soil erosion, and over utilization of ground water resources. To this end, mathematical and conceptual modeling concepts modeling will be generously infused during this course. In the first half of the course Hydrologic Engineering Center's Hydraulic Modeling System (US Army Corps of Engineers) (HEC-HMS) and Soil Water Assessment Tool (SWAT) will be discussed. Students are expected to complete at least one modeling project using either HEC or SWAT models. Prior knowledge in Geographic Information System (GIS) is not a prerequisite for this course, however, skills in GIS will be a valuable asset to unlock the full potential of conceptual models such as SWAT. Discussion during the second half of the course will focus on groundwater modeling. Classical analytical solutions for confined flow will be introduced and compared with numerical (Finite Difference) solutions, subsequently the numerical solutions to more intricate problems will be evaluated. In this regards, skills in programing (e.g. FORTRAN, Visual Basic) will be advantageous. The groundwater may also include groundwater flow analysis principle of superposition, well hydraulics and steady state in unconfined aquifers.

**Learning Objectives**

* Perform quantitative hydrological analysis.
* Identify major water hazards.
* Demonstrate an understanding of the tools used in water management.

**Intended Learning Outcomes (ILOs):**

Successful completion of the course should lead to the following outcomes:

**A. Knowledge and Understanding:** Student is expected to

**A1.** Usewater resources literature

**A2.** Be familiar with the terminology commonly used in the hydrology literature

**A3.**Describe the major component of hydrological model

**A4.**Understand the physical parameters of the ground water

**A5.** Derive unit hydrograph

**A6.** Be familiar with different peak rate factors of the unit hydrograph

**A7.** Perform routing using Muskingum and kinematic wave equation

**A8.** Formulate numerical solutions (finite difference) for ground water flow problems

**B. Intellectual Analytical and Cognitive Skills:** Student is expected to

**B1.**Critically discuss hydrological modeling results

**B2.**Determine the peak rate factor for a specific watershed

**B3.** Select and implement proper boundary conditions for ground water boundary value problems

**C. Subject- Specific Skills:** Students is expected to

**C1**.Determine streamflow using watershed using HEC or SWAT model

**C2.**Analyze the output of HEC ot SWAT model

**C3.** Collect the necessary inputs of SWAT or HEC model

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**D. Transferable Key Skills:** Students is expected to

**D1.**Devise watershed hydrological model

**D2.**Determine the appropriate CN

**D3.** Derive numerical solution using finite difference model

**D4.** Suggest and demonstrate solutions to common water management challengesusing numerical and conceptual models

**Course Contents**

|  |  |  |  |
| --- | --- | --- | --- |
| **No. of 1.5 hour lecture (s) /Week** | **Subject** | **Sources** | **ILO** |
| **4 / 1st,2ndwk** | * Introduction
* Conceptual hydrological mode
* Review of basic principles
* Unit Hydrograph
* φ-index
* Soil Conservation Services (SCS) method
* Synthetic Unit
 | Ref 2, 4 | A1, A2, A3,A5,A6, B2,D1,D2 |
| **2/ 3rdwk** | * Routing
* Kinematic wave equation
* Muskingum equation
* Overland flow
 | Ref 2, 4 ,6 | A1, A2, A3,A7,D1, |
| **4/4th, 5th** | * Introduction to HEC-HMS model
* Data requirements
* Modeling surface runoff
* In class HEC-HMS exercises
* Model calibration and validation
 | Ref 6 | A1, A2,B1,C1, C2,C3,D1,D4 |
| **4/ 6thand 7th** | * Introduction to QSWAT (QGIS/SWAT) model
* Digital Elevation Model (DEM)
* Soil Map and land use Maps
* Climatic data
* Automatic calibration and validation
 | Ref 6 | A1, A2,B1, C1,C2,C3,D1,D4 |
|  | First Exam (20-3-2017) |  |  |
| **4/8th, 9th** | * Groundwater hydrology
* Groundwater flow equations
* Steady flow in confined and unconfined aquifers
* Heterogeneity an anisotropy
* Analytical solutions for confined flow
 | Ref 1, 5 | A1, A2, A4,D1 |
| **6/10th, 11th and 12th** | * Numerical solution for groundwater flow problems
* Finite difference method (FDM)
* Implementation of Boundary conditions
* Numerical models verification
 | Ref 1,5 | A1, A2,A8,B1, B3,D1,D3 |
| **6/ 13th and 14th** | * Temporal and spatial drawdown analysis
* Single well tests
 | Ref 1 | A1, A2,A8,D1 |
| **15thwk** | Exam week |  |  |

**Learning Methodology**

# Question and answer teaching method will be used in this course; therefore, the students are encouraged to participate in classroom discussions. All study material will be circulated electronically, made available at the instructor’s website. The lectures will focus on comprehensive understanding of the course material and problem solving. The homework problem sets are designed to help the students to widen their understanding of the course material and practice their problem solving skills.

# Evaluation

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| --- | --- | --- |
| **Evaluation** | **Point %** | **Date** |
| **First Exam** | 15 | March 20, 2017 |
| **SWAT or HEC modeling project (in lieu of second exam)** | 15 | Project deadline: April 24, 2017 |
| **In class problem sets,homework and quizzes** | 30 | Throughout the semester. Homework or problem sets may be assigned after each topic |
| **Final Exam**  | 40 | Exam week  |

**Main Reference/s:**

1. Bear, J. 1979*. Hydraulics of ground water*. New York: McGraw Hill.
2. Chow, V. T., Maidment, D. R. and Mays, L. W. 1988. *Applied hydrology*. McGraw-Hill.
3. Freeze, R. A. and Cherry J A. 1979. *Groundwater*. Prentice –Hall, Inc.
4. Song, X., Kong, F., and Zhu, Z. 2011. Application of Muskingum routing method with variable parameters in ungauges basin. *Water Science and Engineering 4(1): 1-12.*
5. U.S. Army Corps of Engineers. 1999. *Engineering and design : groundwater hydrology*. Washington D.C.
6. http://www.hec.usace.army.mil/software/hec-hms/

**Suggested Grading Scale**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From (%) | To (%) | Scale | Letter Grade | Result |
| 86 | 100 | 4 | A | Excellent |
| 83 | 85 | 3.75 | A- | Excellent |
| 80 | 82 | 3.5 | B+ | Very Good |
| 74 | 79 | 3.0 | B | Very Good |
| 71 | 73 | 2.75 | B- | Very Good |
| 68 | 70 | 2.5 | C+ | Good |
| 62 | 67 | 2.0 | C | Good |
| 59 | 61 | 1.75 | C- | Good |
| 56 | 58 | 1.25 | D+ | Accepted |
| 50 | 55 | 1.00 | D | Accepted |
| 47 | 49 | 0.75 | D- | Fail |
| 0  | 46 | 0 | F | Fail |

**Tips for Success**

* Results from previous semesters showed that successful student are those who attended the classes regularly.
* Solve all your homeworks yourself, it’s worth the effort. Consider the following popular saying**: "**Ihear and I forget. I see and I remember. ***I do and I understand***."

**Notes and class room policies**

* Regular and timely attendancesare expected from all students. University regulations concerning class attendance will apply
* The students are expected to submit homeworks in due time, a late submission will result in 20% deduction of the homework grade and will not be accepted once the key answers are provided
* Exams absentees are allowed to write makeup exams only if an acceptable and documented excuse is provided; for example, a medical report. Makeup exams are usually more difficult than regular exams
* Zero tolerance for cheating and plagiarism
* Use of cell phone is prohibited
* For more details on University regulations please visit: <http://www.ju.edu.jo/rules/index.htm>