<table>
<tr><th colspan="5">Engineering Hydrology Module</th></tr>
<tr><td>Course Title</td><td colspan="4">Ground Water Hydrology</td></tr>
<tr><td>Course Code</td><td colspan="4">WRIE2095</td></tr>
<tr><td>Program</td><td colspan="4">B.Sc in Water Resources and Irrigation Engineering</td></tr>
<tr><td>Course Coordinator</td><td colspan="4">Name: . ……..
Office location . ……..
Mobile: . ……; e-mail: …….
Consultation Hours: _____</td></tr>
<tr><td>Instructor Name</td><td colspan="4">Name: . ……..
Office location . ……..
Mobile: . ……; e-mail: …….
Consultation Hours: _____</td></tr>
<tr><td>Course Information</td><td colspan="4">Academic Year
Year :
Semester:
Meeting Day:
Meeting Time:
Meeting Location:</td></tr>
<tr><td>ECTS</td><td colspan="4">5</td></tr>
<tr><td>Students’ work load in hrs</td><td>Lecture</td><td>Tutorial</td><td>Lab</td><td>Home study</td></tr>
<tr><td></td><td>2</td><td>2</td><td>0</td><td>4</td></tr>
<tr><td>Course objectives & Competences to be Acquired</td><td colspan="4">• Provides basic theories, principles and mathematical model governing subsurface flow.
• Deals with subsurface storage mechanism and flow pattern.</td></tr>
<tr><td>Course Description</td><td colspan="4">• Ground water resources: Scope and occupancy; ground water in hydrologic cycle; different types of aquifers and their characteristics.
• Ground water movement: Darcy's law, mathematical treatment of frequently occurring flow problems, one-, two- and three-dimensional flow in phreatic, confined and semi-confined aquifers.
• Laboratory and field determination of hydraulic conductivity, determination of ground water flow parameters.
• Hydraulics of wells: steady and unsteady states of flow in, phreatic, confined and unconfined aquifers. Solution methods; graphical methods, use of image wells;
• Groundwater modeling: Mathematical, Physical and numerical models, Modeling of flow in porous media,
• Modeling of pollutant transfer in porous media. Application of mathematical models to the study of ground water flow problems;</td></tr>
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	unsteady flow in leaky aquifers; partially penetrating wells; multiple well systems. • Pumping test, design of piezometres, analysis and interpretation of data, Management of groundwater systems.
Pre-requisite	**Introductory hydrology and Hydrometry**
Status of Course	**Compulsory**

Schedule/syllabus

Week	**Topics**	**Required Text**
	1. Occurrence of Groundwater 1.1 Ground Water Resources 1.2 Occurrence of Ground water 1.2.1 Unsaturated Zone/Zone of aeration 1.2.2 Saturated Zone 1.2.3 Aquifers and their characteristics 1.2.4 Determination of groundwater flow parameter	
	2. Movement of Ground water 2.1 Darcy's law 2.2 Hydraulic conductivity 2.3 Hydraulic flow and Transmissivity 2.4 Flow in anisotropic aquifer 2.5 Ground water Flow direction 2.5.1 Flow nets 2.5.2 Flow in relation to groundwater contours 2.6 Ground water flow equations	
	3. Well Hydraulics 3.1 Steady Radial flow to a well 3.1.1 Confined aquifer 3.1.2 Unconfined aquifer 3.2 Unsteady Radial flow to a well Confined Aquifer 3.2.1 Unconfined aquifer 3.3 Unsteady Radial flow to a well in leaky aquifers 3.4 Partially penetrating wells 3.5 Multiple well systems 3.6 Well losses and specific capacity	

	4. Pumping tests of wells 4.1 Test wells and observation wells	
	4.2 Performing pumping tests 4.3 Methods of Analysis and Interpretation	
	5. Introduction to Ground water modeling	
Summary of Teaching and Learning Method	Lecture, discussion, individual work, problem solvig	
Assessment	1. 20% Test	
	2. 30% assignment and project work	
	3. 50% Final-exam	
Course Expectation	**Preparedness and participation**: both students and the teacher should be prepared since education is an interactive process. Students should be active participants in the teaching-learning process. They should be interested to the course and come to class with the necessary materials such as exercise books and pen. In addition, they should to take responsibility in their education. Teachers are also expected be prepared and interested to the course, which they are offering. They have to consult the essential materials ahead of time and try share their knowledge in an efficient and effective manner. **Material availability**: reference materials are expected to be available in the library nearest to respective faculties.	
Policy	**Attendance**: students should attend at least 85% **Assignments**: all students must do all the assignments given **Tests/quizzes**: all students must sit/take all tests/quizzes given **Cheating/plagiarism**: cheating/plagiarism is strictly forbidden. It will result in disqualification of the course.	
Reference	• Bouwer, H. (1978) Ground Water Hydrology. McGraw Hill, New York. • Driscoll, Fletcher G. (1986) Ground Water and Wells. 2nd Edition, Johnson Filtration Systems Inc, USA. • Kresic, N. (1997) *Quantitive Solutions in* Hydrogeology and Groundwater Modeling. CRC-Press, USA. • Kruseman, G.P. & de Ridder, N.A. (1994) Analysis and Evaluation of Pumping Test Data. 2nd Edition, ILRI, The Netherlands • Ragunath, H.M. (1982) Ground Water. 2nd Edition, New Age International, New Delih. • Fetter, C.W., 1980. Applied Hydrogeology, E-Merril publishing company, New York. Todd, D.K. (1980) Ground Water Hydrology. 2nd Edition, John Wiley and Sons, California	