Course Title	Water Resource Systems
Course Instructor	Dr. Saroj Kunar Chapagain and Dr. Geetha Mohan
Semester	Autumn 2021

Course description:

Water resources are under immense pressure due to increases in water demand owing to population growth and expanded industrial, economic, and service activities. The stress has been further exacerbated by increasing water exploitation, water pollution, and global climate risks. An adequate water quantity and quality are essential for the sustainable growth of any region or country. This course aims to provide a broad understanding of the hydrological processes, socio-economic development, global environmental changes, and their roles and interaction in water resources management. This course highlights the importance of integrated water resources management, providing watershed and system concepts. It provides technical know-how on remote sensing and GIS in environmental monitoring and water-induced risk analysis. Predominantly, the course covers groundwater hydrology, water quality issues, climate change projections, economic analysis, social well-being, and sustainable water resources management. The course offers various issues related to water resources and sustainability through successful case studies and field visit.

Learning Outcome:

The students will gain a comprehensive overview of water and its relation to economic, environment and human well-being. The students will be familiar with global and regional water-related issues and acquire basic knowledge and techniques to manage water-related problems.

Course breakdown

Lecture	Title
1	**Introduction of water resources** Basic terminologies related to water resources, concept of watershed, water budget, basic rainfall-runoff models
2	**Groundwater hydrology** Groundwater definition, types of aquifers (confined/unconfined), groundwater recharge, groundwater movement; basic Darcy's law
3	**Wastewater: opportunities and challenges** Wastewater (types), focus on domestic wastewater and its situation in developing countries, wastewater treatment systems (centralized/decentralized)
4	**Estimation of sectoral water use, and pollutants loads** Quantification of sectoral water use and pollution loads using coefficients
5	**Water quality and basic water quality modeling** Point source, non-point source pollution, water quality monitoring, water quality modeling (concept and application)
6	**Climate change and water resources** Concept, climate projections, climate change impact studies
7	**Water resources and extremes** Water extreme events (floods and drought risk), dam, and physical infrastructure development and management
8	**Application of GIS and remote sensing in water-related research** Basic of GIS and RS; flood risk mapping, water quality monitoring
9	**Role of integrated water resources management** Basic principles and practices of IWRM, understanding of water as a social and economic good (with case study examples)
10	**Challenges for sustainable water resource management** Sustainability concept, water challenges for sustainable development, water resource management policies and tools
11	**Economic analyses for water resources-I & II** Overview of Input-output analysis, developing water budgeting tables
12	**Water for social well-being** Water conflicts and migration. women and water
13	**Field visit (Water supply & management - Lake Kasumigaura)**
14	**Presentation by students**
15	**Assignments/Examination**

Assessment criteria:
Assessment will be based on class attendance, presentation and discussion, a short final test and extended essay with the following allocations;

- Active attendance: 20 % of total marks (80 % attendance is required)
- Assignment: 30% of total marks (Critical review on topics chosen by the students based on the above lectures)
- Presentation: 20% of total marks (15 minutes presentation on water resource systems including question and answers, maximum number of slides not more than 10)
- Written examination: 30%

Reading materials:

- Water Resources Engineering by Larry W. Mays, John Wiley & Sons, 2nd Edition, 2010.
- Applied Hydrology by Ven Te Chow, David R. Maidment, Larry W. Mays, McGraw-Hill Publishing Company; International edition (1988/09).
- IPCC AR5 WG 2 Summary report for policy makers, 2014.
- World Water Assessment Programme (2009): The United Nations World Water Development Report 3. Water in a Changing World, UNESCO, Part 1 (Ch. 1, 3, 5), Part 2(Ch. 7, 8), Part 3(Ch. 10,11)
- Water Evaluation and Planning System (2012): A collection of stand-alone modules to aid in learning the WEAP software (http://www.weap21.org/index.asp?action=213)
- Remote sensing and GIS for Water Resources Management, Version 2, IIT, Kharagpur (http://nptel.ac.in/courses/105105110/pdf/m6l03.pdf)
- Example of the use of CropWat 8.0
- (http://www.fao.org/nr/water/docs/CROPWAT8.0Example.pdf)
- FAO Irrigation and Drainage Paper No. 56, 1998. Crop Evapotranspiration – guidelines for computing crop water requirements
- Daene C. McKineey (2013): Chapter 2. Economic Analysis of Water Resources, http://www.caee.utexas.edu/prof/mckinney/ce385d/Papers/EconNotes.pdf