TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

COURSE OUTLINES

OF

M. Sc.IN LAND AND WATER ENGINEERING

FEBRUARY, 2018

1. **INTRODUCTION**

The Master of Science (M.Sc.) program in Land and Water Engineering is offered by Department of Agricultural Engineering at Purwanchal Campus, Dharan of Institute of Engineering, Tribhuvan University. The title of the program is Master of Science (M.Sc.) in Land and Water Engineering.

2. **OBJECTIVES OF THE PROGRAM**

To train engineers in technical and analytical skills of land and water engineering with latest methods of survey, planning, analysis, design and management of land and water related resources and structures. The graduates of this program will be able to:

   a. Carry out higher studies;
   b. Promote as professional engineers in planning, design and management in the areas of Land and Water Engineering.

3. **ADMISSION REQUIRMENTS**

3.1 Program Entry Requirements: In order to be eligible for admission for Master of Science in Land and Water Engineering, a candidate must have:

   a. A Bachelors' Degree from a Four Year Agricultural Engineering Program orin Civil Engineering from Tribhuvan University or from any other recognized university as well as degree equivalent to any of the aforementioned branches of engineering.
   b. Secure at least a minimum score as prescribed by the Faculty Board in the admission test conducted by the Institute of Engineering.

3.2 Entrance Examination: The nature of entrance test will be decided by the Entrance Examination Board of the Institute of Engineering, Tribhuvan University.

3.3 Selection: Candidates fulfilling the Program Entry requirements will be selected for admission on the basis of merit based on Entrance Test.

3.4 Categories of Students: Three categories of students are envisaged in this course and they are:

   a. Regular fee paying students
   b. Full Fee paying students
   c. Sponsored students

3.5 Duration of Study: The normal durationof the course for the fulfillment of the degree is two academic years. The maximum period within which a student is allowed to complete the course is four years. Each student must take a minimum of 60 credits. Students may take more than 60 credits but the excess credit will not be counted for.

4. COURSE STRUCTURE AND OVERVIEW

4.1 Contents: The courses offered in the program are classified into two groups, namely, core courses and electives. Core courses are the ones which are fundamental in nature and which each student of the program must learn. These courses provide essential knowledge or pre requisite for taking up higher level courses in the area of Land and WaterEngineering. Elective courses allow the students to specifically train them in a particular direction, for example, in the direction of higher studies and research, or in the direction ofplanning, design and management related to land and water resources.

In addition to the courses, each student has to undertake a project thesis of 16 credits. The project essentially provides research training to the students. The students will work on specific topic under the guidance of supervisor. The students are encouraged to think independently, to do systematic review work, to develop computer software or to carry out laboratory experiments and present the outcome of the work in the form of a dissertation (thesis).

4.2 Credit system: The course curriculum is organized in the overall frame work of credit system. The prominent features of the credit system are the process of continuous assessment of student's performance, and flexibility allow a student to progress at an optimum pace suited to his ability and convenience. Each course has certain number of credits which describes its weightage. The number of credits depends upon the contact hours for the course and its work load. A course, in general, is designed for a 3 hours lecture contact and 1 hour tutorial (or assignment discussion) contact per week. This is denoted by a level (3-1-0) indicating '0' contact hour for laboratory. The courses having laboratory contacts will have levels like, 1-0-3 indicating 1 hour lecture contact, 0 hour tutorial contact and 3 hours laboratory contact. Generally, a 3-1-0 Level Course is assigned a credit of 4.

4.3 Course Codes: Each course offered by the institute is defined by the institute and identified by two letters, EG, Followed by three number digit and two letters. The first digit denotes the program and the year in which the course is normally taken. The first digit 8 and 9 indicates the first and second year respectively of Master level course. The second digit from 0 to 4 is used for courses offered in the first semester and 5 to 9 for the second semester. The third digit is used to identify the particular course. The last two letters denote the department, which offer the course.
Example: EG 802 CE Denotes the course 'Advance Structural Analysis' which is offered in the first year first semester of M.Sc. Program by Department of Civil Engineering.

The Courses offered and Marks distribution (M. Sc. in Land and Water Engineering)

Year : I **Part I**

Teaching Schedule				Examination Scheme			Total	Remarks
					Final			
S. N.	Course Code	Course title	Credit	Assessment Marks	Duration Hours	Marks		
1		System Analysis for Land and Water Resources	4 (3-1-0)	40	3	60	100	
2		Advanced Hydrology	4 (3-1-0)	40	3	60	100	
3		Geo-Hydro Informatics for Land and water Resources	4 (2-0-2)	40	3	60	100	
4		Elective I	4 (3-1-0)	40	3	60	100	
			16	**160**		**240**	**400**	

Year : I **Part II**

Teaching Schedule				Examination Scheme			Total	Remarks
					Final			
S. N.	Course Code	Course title	Credit	Assessment Marks	Duration Hours	Marks		
1		Planning, Design and Management of Land and Water Resources	4 (3-1-0)	40	3	60	100	
2		Land and Water Engineering Lab	4 (0-0-4)	100			100	
3		On-Farm Irrigation and Drainage	4 (3-1-0)	40	3	60	100	
4		Elective II	4	40	3	60	100	
			16	**220**		**180**	**400**	

Year : II **Part I**

Teaching Schedule				Examination Scheme			Total	Remarks
					Final			
S. N.	Course Code	Course title	Credit	Assessment Marks	Duration Hours	Marks		
1		Elective III	4 (3-1-0)	40	3	60	100	
2		Elective IV	4 (4-0-0)	40	3	60	100	
3		Project Work and Seminar	4	100			100	
			12	**180**		**120**	**300**	

Year : II **Part II**

Teaching Schedule				Examination Scheme			Total	Remarks
S. N.	Course Code	Course title	Credit	Assessment Marks	Final			
					Duration Hours	Marks		
1		Thesis Work	16	100			100	
			16	**100**			**100**	

ELECTIVE COURSES

Teaching Schedule				Examination Scheme			Total	Remarks
S. N.	Course Code	Course title	Credit	Assessment Marks	Final			
					Duration Hours	Marks		
Elective I								
1		River Engineering	4 (3-1-0)	40	3	60	100	
2		Computational Hydraulics	4 (3-1-0)	40	3	60	100	
3		Integrated Watershed Management	4 (3-1-0)	40	3	60	100	
4		Land Development Machinery	4 (3-1-0)	40	3	60	100	
Elective II								
1		Climate Change for Land & Water Resources	4 (3-1-0)	40	3	60	100	
2		Environmental Impact Assessment	4 (3-1-0)	40	3	60	100	
3		Land, Water, Environment and Food Nexus	4 (4-0-0)	40	3	60	100	
4		Computer Programming for Land and Water Engineering	4 (2-0-2)	40	3	60	100	
Elective III								
1		Non-Point Source Pollution & Management	4 (3-1-0)	40	3	60	100	
2		Disaster Management	4 (3-1-0)	40	3	60	100	
3		Design of Dams	4 (3-1-0)	40	3	60	100	
4		Sectoral Water Demand and Distribution	4 (3-1-0)	40	3	60	100	
Elective IV								
1		Economics of Land and Water Resources	4 (4-0-0)	40	3	60	100	
2		Socio-political Dimensions of Land and Water Management	4 (4-0-0)	40	3	60	100	
3		Science of Happiness and Well-being	4 (4-0-0)	40	3	60	100	

4.4 Instructional Methods: Every course is co-ordinated by a faculty member of the Department which is offering the course in a given semester. This faculty member is called the Course Coordinator and has the full responsibility for conducting the course, coordinating the work of other members of the faculty involved in that course, holding the test and assignments, and awarding marks. For any difficulty the student is encouraged to approach the course coordinator for advice and clarification. Apart from the lectures, though which the course is delivered, a certain number of assignments will be given in each course. Each assignment or a tutorial sheet consists of a number of problems that covers a particular section of the course. The problems are set in such a fashion that the students understand thoroughly the subject matters presented in the section after solving them. Generally, 4 to 8 assignments are given in each course. Tutorial contact hour, allotted in a course, are utilized for assignment discussion and augmentation of lectures. Practical classes in the form of laboratory works or computations are used to verify the concepts and to develop necessary technical and analytical skill. The program, in general emphasizes on process of self learning.

4.5 Registration: Every student must register and seriously attempt to complete all the courses including project work in two years. In the first two semesters a total of 8 courses will be offered with 4 courses in each semester. Out of 4 courses in a semester, 3 courses in the first and 3 courses in the second semester will be from the list of core courses; the rest will be floated from the list of elective courses. While Core Courses to be offered in each semester are fixed, the elective courses that will be offered in a semester may vary and depend upon the convenience of teaching, and other administrative factors.

Students should follow following requirements:

(a) A student will normally be allowed to register for a minimum of 12 credits and maximum 24 credits per semester.

(b) A student shall successfully complete, as a minimum requirement, the Course Work of 12 Credits including at least 2 core courses in I semester to be eligible to register for II semester.

(c) A student shall successfully complete, as a minimum requirement, the Course Work of 12 Credits including at least 2 core courses in II semester to be eligible to register for III semester.

(d) A student may register for Research Project Work (Thesis) in III semester only after successful completion of 24 credits with at least 4 core courses in the preceding semesters.

(e) If a student registers for Research Project Work (Thesis) in III semester, he/she may register for a maximum of 12 credits of Course Work but not more than 2 Core Courses.

(f) If a student registers for Research Project Work (Thesis) in IV semester, he/she may register for a maximum of 8 credits of Course Work.

5. EVALUATION

5.1 Evaluation System: The evaluation system is based on the continuous assessment by the course teacher and the final examination. The students have to pass individually in the assessment as well as the final examination. The minimum pass marks for the assessment and final examination is 50%.

The percentage is calculated from the following criterion:

$$Total\ Percentage = \frac{\sum Credit\ X\ Mark\ Obtained}{\sum Credit}$$

Depending upon the total percentage of the marks obtained, the following division shall be awarded:

Percentage	Division
80 and above	Distinction
65 - < 80 %	I
50 - < 65%	II
>= 50 %	Pass

5.2 Qualifying Criteria: To qualify for the degree of Master of Science in Land and Water Engineering, a student must satisfactorily complete a program of course work of 60 credits including an independent Research Project work (Thesis) of 16 Credits.

6. COURSE OUTLINE

6.1 CORE COURSES

Core 1: System Analysis for Land and Water Resources (3-1-0)

Credit: 4 Hours **Year/Semester: I/I**

Nature of water resources systems: Systems analysis - the jargon used, methods of systems analysis; **Linear programming models**: Concept of simplex tableau, its working principles, two phases of simplex method, revised simplex method, duality, decomposition principle, post optimality analysis, Transportation problem; **Non-linear programming** of simple cases; **Dynamic programming**: Multi stage decision process, computational procedure in dynamic programming, basic concepts of probability, stochastic linear and dynamic programming, application of systems analysis to land and water resources systems in particular.

Core 2: Advanced Hydrology (3-1-0)

Credit: 4 Hours **Year/Semester: I/I**

Surface Water Hydrology: Precipitation: Mechanisms, types, spatial and temporal variation, design storm; **Infiltration:** Process, measurement, modeling (Horton, Green-Ampt, SCS); **Evaporation and Evapotranspiration:** Process, measurement and estimation; **Stream Flow and Gauging:**Hortonian and saturation overland flow mechanisms, factors affecting base flow, Stream gauging and generation of flow data**,** Analysis of discrete and continuous hydrologic data; **Hydrograph analysis:** Drainage basin characteristics, UH theory, IUH and GIUH; **Flood Routing:** Reservoir routing, channel routing, Muskingum-Cunge method, diffusion wave routing; **Hydrologic Design:** Uncertainty concepts, first order reliability method (FORM), risk based design of water resources projects; basics of stochastic modelling of hydrologic processes.

Ground Water Hydrology: Fundamentals of Groundwater: Groundwater problems, effective porosity, storage coefficient, specific yield, fillable porosity and safe yield, primary and secondary porosity, homogeneity and isotropy, Darcy's law and its validity, recharge estimation, aquifer hydraulics. **Environmental Impacts on Groundwater:** Temporal variation of groundwater levels, groundwater-surface water interaction, evapotranspirative fluctuations, meteorological fluctuations, impacts of urbanization, earthquakes and external loads on groundwater, land subsidence. **Aquifer Tests and Parameter Estimation:** Need of aquifer tests, type and design of aquifer tests, test procedures, merits and demerits of pumping test, steady and transient methods for determining aquifer parameters from pumping test data, recovery test, analysis of step-drawdown test data, slug tests. **Groundwater Quality and Contamination:** Definitions, water-quality parameters and characteristics, monitoring of groundwater quality, water-quality criteria and standards, collection of groundwater samples, vadose zone monitoring, groundwater contamination, sources and causes of groundwater contamination, attenuation of groundwater contamination, groundwater restoration, case history, capture zone analysis. **Groundwater Modeling:** Definitions and terms, model types, brief history of groundwater modeling, application of models in hydrogeology, data requirements for numerical modeling, modeling protocol, development of finite-difference and finite-element groundwater models, introduction to inverse modeling, overview of salient groundwater flow and transport software packages, salient case studies.

Core 3: Geo-Hydro-Informatics for Land and Water Resources (2-0-2)

Credit: 4 Hours **Year/Semester: I/I**

Electromagnetic spectrum; Energy interactions; Platforms and remote sensing sensors: Photographic camera, scanners, earth resources satellites, active and passive microwave sensors; Digital image processing: Image rectification, image enhancement, image classification and accuracy, Image interpretation. Introduction to GIS; Map Projections and Coordinate Systems; GIS Data Formats: Vector and raster data, TIN; GIS Data Input: digitizing, remote sensing, field data and GPS; Spatial Analysis: Vector and raster analysis, measurement, query, statistical surfaces (DEM); Accuracy and Errors; GIS Output: Map functions in GIS, map design and elements; GPS Fundamentals: GPS system, accuracy and sources of error in GPS. Case Studies: RS and GIS application in land and water resources systems.
Laboratory Works: Digital database creation: point, line and polygon features; Data processing: dissolving and merging, clipping, intersection, union, buffering techniques; Spatial and attribute query; Spatial analysis and modeling; Digital terrain modeling; Application of GPS in field survey.

Introduction to hydro-informatics: Data-driven modeling for water systems, Model classification, Models overview, Modeling accuracy, Introduction to machine learning and artificial intelligence; **Hydro-informatics in water management**: Information and communication technologies applied in hydro-informatics, Acquisition and processing of input data, Simulation models, Processing of model's output data; **Rainfall-Runoff models:** HEC-HMS;

AWBM; SWAT; **Modeling of water flow in open channels and floodplains:** HEC-RAS; **Ground water flow modeling**: Processing MODFLOW; **Pipe system flow modeling:** Pipe Flow

Core 4: Planning, Design and Management of Land and Water Structures (3-1-0)

Credit: 4 Hours **Year / Semester: I/II**

Land and Water Use Planning: Need, importance and identification of land and water resources; Land use policy of Nepal; Types and management of land use; Land use zones and their characteristics; Land suitability; Land use mapping and its applications; Process of planning; Levels of planning. **Design of Structures:** Types of structures, principles and factors for their design; Soil and Water Conservation Structures:Bunds, Grassed waterways, Terraces, Check Dams, Retaining walls, Gully control structures; Drainage Structures: **S**mall bridges, causeways, culverts and side drains; Irrigation Structures:Weirs, drops and outlets; Water Harvesting Structures:Small earthen dams, sand dams and farm ponds. **Management of Land and water Resources: C**auses and types of land degradation,Reclamation and management of saline, sodic, waterlogged and salt affected soils, Economics and social aspects of land reclamation, Storm water management,Groundwater mining and sustainable groundwater management, 'safe yield' versus 'sustainable yield', Methods of artificial recharge, Sources of recharge water, Hydraulics and monitoring of artificial recharge, Conjunctive use of surface water and ground water; Injection wells and spreading basins; Techniques for groundwater management.

Core 5: Land and Water EngineeringLab (0-0-4)

Credit: 4 Hours **Year/Semester: I/II**

Measurement of irrigation water, Determination of soil infiltration characteristics, Study of advance and recession flow in different surface irrigation systems, Performance evaluation of sprinkler and drip systems, Study of different types of filters used in micro irrigation systems, Evaluation of control systems used for fertigation, Assessment of major and minor losses in pipeline irrigation distribution network, Determination of hydraulic conductivity, Determination of various soil and water quality parameters in saline/sodic/saline-sodic soils, Development of soil moisture characteristics curves.
Measurement of rainfall, evapo-transpiration, infiltration and stream flow; measurement of flow in open and pressure conduits, measurement of major and minor friction head losses, in situ determination of soil moisture, watershed delineation and characterization. Groundwater investigation by Resistivity Meter and EM Meter, monitoring of groundwater level and quality, preparation of groundwater contour maps and their analysis, determination of hydraulic parameters of confined, and unconfined aquifer systems by pumping test, analysis of step- drawdown test data.

Core 6: On-farm Irrigation and Drainage (3-1-0)

Credit: 4 Hours **Year/Semester: I/II**

Irrigation Systems and Water Management in Nepal: Annual utilizable water resources of Nepal, annual water demand for irrigation and other purposes, water balance, significance of irrigation in Nepal, classification of irrigation systems, irrigation potential and expansion, prevalent water allocation and distribution practices, irrigation management organizations, overview of water management in Nepal, national water policy, concept of sustainable development and its criteria, sustainable water use; **Canal Irrigation Management:** Layout of irrigation systems, need for canal irrigation management, causes of poor performance of irrigation systems, strategies for improving canal irrigation management, modern concepts of irrigation management, irrigation efficiencies, canal outlets and their suitability, criteria for analyzing the behavior of outlets, canal regulation, performance evaluation of irrigation systems; **Farm Water Delivery System and Control:** Design of field channels and underground pipelines, water regulating and diversion structures; **Irrigation Requirements and Scheduling:** Evapotranspiration, direct measurement and estimation of evapotranspiration, effective rainfall, irrigation scheduling, scheduling strategies, crop production functions; **Waterlogging, Salinisation and Lining of Distribution System:** Effects and causes of waterlogging, salinisation process and damage, average root zone salinity, use of marginal and poor quality water, salt balance calculations, remedial measures, conjunctive use of surface water and groundwater, canal losses, lining of irrigation channels, types of lining, design of lined canal, economics of canal lining; **Farm Irrigation System Design:** Types of farm irrigation systems, application methods and design, performance evaluation of farm irrigation system; **Micro Irrigation Systems:** Micro irrigation systems versus surface irrigation systems, types of sprinklers, principles of sprinkler operation, uniformity coefficient, economic design of a sprinkler system, system design efficiency, trickle irrigation systems, control head, trickle system components, water distribution in the soil profile, trickle system design, fertigation, irrigation automation; **Drainage of Irrigated Land:** Drainage problems, sources of excess water, drainage systems, drainage requirements, planning and design of drainage systems, design of pipe drainage systems, well drainage, mole drainage, cost evaluation of drainage projects.

6.2 Elective Courses

Elective I: River Engineering (3-1-0)

Credit: 4 Hours **Year/Semester: I/I**

River characteristics; use of rivers for navigation, hydropower, water supply and irrigation; river hydraulics - water waves, flow classification, regime of flow, type of flow; formulating hydraulic studies - date requirement, calibration of hydraulic analysis models, multidimensional flow analysis, limitations of one-dimensional analysis, two-dimensional conditions, available computer programs and their applications, theory of routing models for unsteady flow, diffusion of wave and kinematic wave approximations, Muskingum-Cunge models, water surface profiles for mobile boundaries; river morphology - planform, longitudinal profile, river bends, bifurcation and confluences, quality of water; river survey - water levels, bed levels, discharge, stage discharge relationships, sediments and water quality, introduction to scale models in rivers.

Elective I: Computational Hydraulics (3-1-0)

Credit: 4 Hours **Year/Semester: I/I**

Ordinary and partial differential equations; finite difference schemes - implicit and explicit types; accuracy, convergence and stability; method of characteristics; finite element method - variational and weighted residual formulations; applications to steady and unsteady flows; pollutant dispersion; flood wave propagation; applications with computer programming.

Elective I: Integrated Watershed Management (3-1-0)

Credit: 4 Hours **Year/Semester: I/I**

Introduction to integrated approach for the management of watersheds; preparation of land drainage schemes; types and design of surface drainage as well as subsurface drainage; controlling of soil erosion and soil salinity; types and design of water conservation and water harvesting structures for different types of catchments; estimation of design storm and design flood for spillways and other outlet structures; flood routing through channels and reservoirs; flood control through single purpose and multipurpose reservoir operation; types and design of flood forecasting and protection systems; flood damage case studies.

Elective I: Land Development Machinery (3-1-0)

Credit: 4 Hours **Year/Semester: I/I**

Introduction: Role of machineries in land development, Classification of land development machineries, Basic soil manipulations; **Soil wheel interaction:** Mechanics of traction devices, Rolling resistance and tractive effort, Drawbar pull and rim pull, Traction devices and traction aids; **Tractor:** History and development, types and functions, Power estimation, Efficiency and reliability of tractor, Human factors in tractor design; **Bulldozers:** Crower mounted verses wheel mounted bulldozer, Efficiency of bulldozer; **Scrapers:** Types and size of scrapers, Operating efficiency of scraper, Performance of wheel type scraper; **Excavating equipment:** Power shovel- general information and basic components, Working principle and size of shovel, Performance of shovel, Drag line- general information and basic components, Types of draglines, Effect of depth of cut and angle of swing on output; **Leveling Equipment:** Basic components, Features of land leveler, Leaser land leveler; **Effects of land development machineries on agricultural land; Economics of land development machineries**

Elective II: Climate Change for Land & Water Resources (3-1-0)

Credit: 4 Hours **Year/Semester: I/II**

Basic concept: Climate and weather, climatic classification, drivers of climate change, overview of changing climate, analysis of climate change and climate forecasting; **Hydrologic system**: Overview, global and national water budget, rainfall and temperature variability, climate change effects on land and water resources (Runoff, ET, Soil Moisture, GW, Sediment), climate change effects on droughts and floods; **Climate forecast**: GCM and RCM, future climate scenarios, assessment of future land and water resources (Runoff, ET, Soil Moisture, GW, Sediment), vulnerability, application of hydrologic models in present and future resources assessment, probabilistic methods of results interpretation of future water resources; **Application of CC forecast:** Climate change adaptation capacity & methods, Sensitivity of the changing climate on resources, application of cc forecast on water resources management (reservoirs, runoff, ground water); **Land use, climate change and sustainability; Environmental Change, Climate and Water Supply, Sanitation Health; Climate Change Economics and Policy.**

Elective II: Environmental Impact Assessment (3-1-0)

Credit: 4 Hours **Year/Semester: I/II**

Technical and procedural aspects of Environmental Impact assessment, Guidelines and legal aspects of environmental protection, General Framework for characterising environmental dislocation disruption due to pollution, Theory and application of mathematical models:- Mathematical modeling for water quality systems, Stream and Estuarine models for pollution control, Socioeconomic aspects, Measures of effectiveness of pollution control activities, Inter-sector pollutant transfers, total impact assessment.

Elective II: Land, Water, Environment and Food Nexus (4-0-0)

Credit: 4 Hours **Year/Semester: I/II**

Introduction: Status of Land and Water in Nepal, Land fragmentation trends in Nepal, Food Security in Nepal; **Land for Food Security:** Agriculture Land and food production, Land Size, quality and Food Security, Land change over time, Community farming; **Water for Food Security:** Water and Food Productivity relation, Water availability, quality and food security, Efficient irrigation techniques; **Instability and Conflict:** Concept of land and water security, Land and water use conflict & instability, Trans-boundary dynamics; **Climate Change:** Climate change impacts on land and water, Adaption and Measures, Land – Water – Food roles on climate change mitigation; **Economics and Business:** Pricing Land &Water, Privatization, externalities, investment, public-private partnership; **Governance:** Treaties and Policies on Land and Water, National plan, policy and strategy for food security, Land and Water use regulation and incentives.

Elective II: Computer Programming for Land and Water Engineering (2-0-2)

Credit: 4 Hours **Year/Semester: I/II**

Review of Programming Language (FORTRAN): Character set (Data Type, Operators, Library function, Input/output statements), Control structure (If, If-Then, Nested if, Loop), Array, Modular Programming; **Numerical solution of nonlinear equations:** Bisection method, Newton Raphson method, Secant method; **Numerical solution for curve fitting:** Interpolation, Newton Interpolation, Lagrange Interpolation, Cubic Spline, Least square fitting; **Numerical solution for Differentiation and Integration:** Differentiation, Integration, Newton cote's, Gaussian; **Numerical Solution for differential equation:** Ordinary differential equation (Taylor series, RK-4), Partial differential equation (Laplace, Poisson); **Introduction to Optimization:** Maximal flow model, Shortest route problem.

Elective III: Non-Point Source Pollution & Management (3-1-0)

Credit: 4 Hours **Year/Semester: II/I**II

Basic concept of water pollution, Standards of drinking water, Water quality standards pertaining to drinking, Irrigation and aquatic life; Water quality analysis methods and instruments used; Concept and behaviour of point and nonpoint source pollution, Sources of NPS pollution, Pathways and assessment of NPS pollution, Pathways and assessment of NPS pollutants, linkage between water pollution and hydrology, Health hazards caused by NPS pollutants, Application of hydrologic models in NPS pollution assessment on watershed scale, Quantification and control of NPS pollution from agricultural watersheds, Watershed scale NPS pollution models, Safe limits of agrochemicals use, Optimum management strategy, Some idea on biological (organic, bacterial (Fecal-Caliform) NPS pollution assessment and management.

Elective III: Disaster Management (3-1-0)

Credit: 4 Hours **Year/Semester: II/III**

Disaster preparedness: Program planning, decision making, information management, program supervision, monitoring and control, personnel, and leadership, motivation, group dynamics, managing work groups, structure and organizations, criteria for addressing a program; **Disaster mitigation measures:** Physical characteristics, geographic distribution, impact, response, and mitigation of natural hazards such as earthquakes, tsunamis, volcanoes, tropical cyclones, floods, drought, desertification, and deforestation, Risk analysis, Management for handling emergency supplies and services for housing, agriculture, lifelines, droughts and famines; establishment of surveillance systems after a disaster, **Disaster-response planning**: roles and responsibilities, initial emergency operations, emergency operations support and management, recovery and rehabilitation; Risk factors for communicable diseases after disasters, Post-disaster potential for communicable disease epidemics, surveillance of communicable and selected non-communicable diseases, Control of communicable diseases after disasters.

Elective III: Design of Dams (3-1-0)

Credit: 4 Hours **Year/Semester: II/III**

Type of dams and their characteristics, Selection and evaluation of dam sites, Investigation of dam foundation, Basics of soil mechanics (settlement, seepage and aspects of stress in relation to dams and dam foundation), Basics of concrete property and dam concrete challenges, Typical cross section and forces acting on gravity dam, Design consideration and fixing of section of dam, Design of filter and slope protection of embankment dams, Criteria and principles of dam stability analysis, Modes of failure and structural stability analysis, Types of joints, Temperature control in concrete dams and foundation treatment; Spillway design flood and hydraulics of overflow spillways, Spillway crest profile and Energy dissipation facilities.

Elective III: Sectoral Water Demand and Distribution (3-1-0)

Credit: 4 Hours **Year/Semester: II/III**

Introduction to water distribution system to different sectors: Domestic, Industrial, Agricultural; Present status of water distribution system in Nepal and Abroad; Types of distribution system: Pipe network, canal network system, lift irrigation; Sources of water distribution system: surface storage reservoirs and run-of-the-river (weirs/ barrages) diversion schemes, surface ponds, open wells, dug wells, tube wells, infiltration galleries, collector wells; Flow mass curve analysis for design of reservoir capacity; Water-demand-supply analysis through population forecasting; Drinking and irrigation water quality standards; Assessment of drinking and irrigation water demands; Components of domestic water supply system; Hydraulics of domestic pipe network design: Single network, looped network; Minimization of losses in domestic water supply system; Pumping systems and storage structures; Design of pressurized distribution system with associated controls and storage structures for drinking and irrigation water supplies; Introduction to pipe network design software EPANET; Automation techniques for drinking water distribution systems using SCADA. Principles of Canal system design. Overview of major and minor conveyance and distribution systems for irrigation water (canals, control structures, cross drainage works, distributaries, water courses and field channel for gravity irrigation); lift irrigation system; Canal hydraulics (computer simulation) models, canal scheduling; Computer models of canal operation.

Elective IV: Economics of Land and Water Resources (4-0-0)

Credit: 4 Hours **Year/Semester: II/III**

Introduction: Nature and Scope of Economics, Economic Elements and Structures, Micro Vs. Macro Economics, Introduction to Environmental Economics, Basic Concept of Supply and Demand and Price Mechanism, Economic efficiency; **Micro Economic Theory:** Introduction, Profit Maximization and Cost Minimization, Theory of Consumer Behavior- Utility, Choice, Demand, Duality, Theory of Market Structures (Competitive and Non-Competitive Markets); **Macro Economic Theory:** International Economics- Capital Flows, Exchange Rates, Business Cycle Theory, Growth Theories- Solow model, New

Growth Theory, Infinite Horizons and Overlapping Generation Models; **Water Resources Economics:** Valuation Techniques- Water Trade and Value Theory, Market Failures, Non-Market Valuation Methods, Economic Rents, Optimal Allocation- Marginal Net Benefit Functions, Opportunity Costs, Economic Efficiency, Water Transfers, Water Pricing- Water Charges, Objectives of Rate Setting, Decision Support System for Water Pricing, Taxation, Polluters Pays Principle, Economic Theory of Pricing; **Managerial Resource Economics:** Review of Free Market Economic System, Market Failures, Economics of Common Property Resource Management, Economics of Renewable and Non-Renewable Water Management; **Case Studies/Analysis:** Case Studies and Analysis of Relevant Cases in Classes

<u>Elective IV: Socio-political Dimensions of Land and Water Management (4-0-0)</u>

Credit: 4 Hours **Year/Semester: II/III**

Society-Natural Resources Interaction: Social Forestry, Irrigation, Biodiversity Conservation, Indigenous Ecological Knowledge, Collaborative Natural Resources Management; **Conflict Management in Land and Water Resources:** Introduction to Conflict (Sources of Conflict, Stages of Conflict Manifestation, Actors involved in Conflict, Conflict Theories- Human Needs Theory, The Nested Theory of Conflict, Identity Theory, Conflict Transformation Theory, Conflicts in Natural Resources Sectors (Dispute at the Source, Conflicts from Allocation of Resources to Multiple Uses, Compensation for Damage, Conflicts Emerging from Entitlement and Use Rights, Transboundary Conflicts, Conflict Emerging from Choices of Technology, Transfer of Water and Conflict to Broader Social and Political Conflict); Conflict Analysis Tools (Stages of Conflict, Conflict Mapping, Conflict Tree, ABV Trainable, Other Tools, Building Strategies to Address Conflict, Techniques in Dispute Resolution, Skills in Conflict Resolution, Working with Options, Criteria and Standards); **Legal and Political Dimensions of Land and Water Resources:** Introduction to Water Law (Genesis of Water Law, Eastern Water Law- Riparianism, Western Water Law- Prior Appropriation and Restriction of Riparian Rights, Customary Laws, Contemporary Developments in Water Laws, Changing Perspectives), Problems and Prospects of Nepalese Water Resources (Potential of Nepal Water Resources, Existing Uses of Nepalese Water Resources, Tranboundary Issues, Relations with Other Countries and Regional Cooperation, Issues of Downstream Benefits), National Water Resources Policy (Review of Existing Policies, Framework of National Water Resources Strategy, Elements of National Water Resources Strategy and their Relevance), Problems and Prospects of Nepalese Land Resources (National Land use Policy and Plan, Land Reform Policy, Land Issues in Nepal, Land Policy Issues in Nepalese Context, Land Cover Changes and its Eco-environmental Responses, Sustainable Management of Land Resources in Nepal); **Concept of Gender and Gender Mainstreaming:** Concept of Gender and Sex, Empowerment Concept and Approach, Gender Mainstreaming- What and How?, Gender Relationship (Intra-household relationship- bargaining power, access/ control), Sex Role Stereotyping, Influence of Social Institutions (Caste, Culture and Religion) in Gender Stereotyping, Global Trends of Gender and Natural Resources, Gender Bias in Technology, Technology Shaping the Society/Gender Relation, Gender Issues in Agricultural Land and Water Use, Gender Issues in Domestic Land and Water Use, Gender Issues in Industrial Land and Water Use, Cooperation and Conflict; **Class Works Simulation:** Case Study Orientation on Gender(Role Play), Case Study and Analysis on Conflict, Case Study and Analysis on Political and Trans-boundary Issues of Land and Water.

Elective IV: Science of Happiness and Well-Being (4-0-0)

Credit: 4 Hours **Year/Semester: II/III**

Defining happiness and understanding its mechanisms: Happiness and the mind, Happiness and the brain; **key ingredients:** Cultural and environmental factors, Personality and attitudinal factors, Genetic factor, Attitudes of happiness; **Happiness within:** key components and how they work, Gratitude, forgiveness, empathy and compassion, Mindfulness; **Happiness without:** Emotional intelligence and stability, Building relationships and developing altruism, field testing happiness with people; **Happiness at work:** Happiness and workplace success, Developing positive workplace strategies for work-life balance, Applying the lessons to every day work life.