24 Water Science and Technology

TRIMESTER WISE DISTRIBUTION OF COURSES

I TRIMESTER

		L	P
WST 501	FUNDAMENTALS OF FLUID MECHANICS AND HYDRAULICS	3	1
WST 502/ ES 502	ENVIRONMENTAL POLLUTION	3	0
WST 503	SOIL- WATER-PLANT- ENVIRONMENT SYSTEM	2	1
WST 505	SOIL & WATER CONSERVATION AND SEDIMENT TRANSPORT	3	0
WST 509	ECONOMIC, SOCIAL AND INSTITUTIONAL ISSUES IN WATER RESOURCE MANAGEMENT	3	0
WST 510/ AG 510 / SSAC 510	MANAGEMENT OF PROBLEM SOILS AND WATERS	3	1
WST 530/ AP 530	FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY	3	1
WST 691	SEMINAR	1	0

II TRIMESTER

WST 500	WATER RESOURCE MANAGEMENT - I	3	0
WST 603	ECONOMIC ANALYSIS OF WATER USE	3	0
WST 511	SOIL AND WATER QUALITY AND IRRIGATION MANAGEMENT	2	1
WST 608	DIAGNOSTIC ANALYSIS AND PERFORMANCE EVALUATION OF IRRIGATION PROJECTS	1	3
WST 611	PRESSURIZED IRRIGATION SYSTEM DESIGN	2	1
WST 504/ AG 504	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	3	1
WST 691	SEMINAR	1	0

III TRIMESTER

WST 600	WATER RESOURCE MANAGEMENT-II	2	1
WST 601	CROP WATER REQUIREMENT AND IRRIGATION PLANNING	2	1
WST 506	HYDROLOGY AND WATERSHED MANAGEMENT	3	1

WST 607	ENVIRONMENTAL IMPACT ASSESSMENT OF IRRIGATION PROJECTS	3	0
WST 614	IRRIGATION HYDRAULICS	2	1
WST 615	WATER MANAGEMENT TECHNOLOGIES IN RAINFED AGRICULTURE	2	1
WST 691	SEMINAR	1	0

Core Courses

M.Sc.: WST 500, WST 501, WST 503, WST 504/AG 504, WST 601 and WST 608.

Ph. D.: WST- 607, WST 611 and WST 615

WATER SCIENCE AND TECHNOLOGY

Major Field : Water Science and Technology

Minor Field : Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.

M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

DESCRIPTION OF COURSES

WST 500 WATER RESOURCE MANAGEMENT – I (3L+0P) II

Objective

To prepare the students with the rationale utilization of land & water resources for optimum production with minimum land and water resources

Theory

UNIT I
Hydrologic Cycle, hydrologic process, Analysis of rainfall data, runoff estimation.

UNIT II
Rain Water Harvesting and Its Management, Development of Surface Water Resource, Basic equations of ground flow, Ground Water Recharge, assessment of ground water recharge, Development of ground water resources

UNIT III
Physical, chemical and biological properties of water, water quality standards for different purposes, Sources of pollution of surface and ground water resources.

UNIT IV
India's water resources and their development, impact of climate change on water resources, water resources data. Water needs for future in different sectors.

Suggested Readings

Larry, W.M. 1996. *Water Resources Handbook.* McGraw-Hill.

Loucks, D.P. *et al.*1981. *Water Resource System Planning and analysis.* Prentice Hall.

Rao, S.S. 1978. *Optimization THEORY and Applications.* Wiley Eastern.

WST 501 FUNDAMENTALS OF FLUID MECHANICS AND HYDRAULICS (3L+1P) I

Objective

To impart the basic knowledge of the fluid mechanics and hydraulics to the students of various background. Such a basic knowledge is a mandatory requirement for those who deal with water transport on to the fields.

Theory

UNIT I

Fluids- definitions, properties, fluid pressure and its measurements, hydrostatic force on surface, buoyancy and floatation.

UNIT II

Hydro kinematics- kinematics of fluid flow, methods of describing fluid in motion, lines of flow: path line, stream line, stream tube and potential line.

UNIT III

General types of fluid flow- steady and unsteady flow, uniform and non uniform flows, laminar and turbulent flows, compressible and incompressible flows, one, two and three dimensional flows.

UNIT IV

Rate of flow/discharge, system, control volume, cross section of flow, concept of mean velocity of flow, Equation of continuity, Stream function, velocity function and flow net.

UNIT-V

Dynamics of fluid flow, basic energy and momentum equation, Bernoulli's theorem for liquid and its proof, Hydraulic and energy grade lines, head and power: horse power, application of Bernoulli's equation.

UNIT VI

Flow through pipes, definition of pipe and pipeline, pipe line problems, siphon, loss of head in pipe, pump in pipe line, most economical diameter of pipe, water hammer, gradual closure of valve, and instantaneous closure of valve.

Practicals

Design problems, Exposure to various hydraulic structures, solutions to class exercises and design exercises of pipe flows.

Suggested Readings

Hydraulics and Fluid Mechanics; Jagdish Lal, Metropolitan Book Co. Pvt. Ltd.

THEORY and Problems of Fluid Mechanics and Hydraulics: Schaum's Outline Series

WST 502/ES 502 ENVIRONMENTAL POLLUTION (3L+0P) I

Objective

To provide the related information on the Environmental Pollutants and their impacts on agriculture and environments

Theory

UNIT I

Introduction to environmental pollution; water borne diseases and their control; biological and chemical indicators of environmental pollution

UNIT II

Sources and type of water pollution; heavy metals in surface and sub-surface waters; pesticide residues in surface and sub-surface waters; phosphates in surface and sub surface waters; uptake of

pollutants by plants; radio-active wastes and their safe disposal;; sampling and analysis techniques; aquatic plants and their role in pollution control-phytoremediation

UNIT III

Particulate and heavy metal pollution of air; atmospheric pollution from fossil fuels used in vehicles and industry; biofuels for air pollution control; ozone layer and its importance; mechanism of ozone layer depletion and diffusion of CFCs; renewable sources of energy.

UNIT IV

Sources and sinks of SOx & NOx in atmosphere; sources and sinks of CO and CO_2 in atmosphere; sources and sinks of CH_4 and nitrous oxide in atmosphere

UNIT V

Solid wastes (crop residues, sludges, food processing industries wasters) and their disposal; sources & nature of soil pollution and their harmful effects; soil and groundwater pollution by nitrates, fluorides and heavy metals.

UNIT VI

Anthropogenic influences on terrestrial and aquatic environments and their copying strategies for greater environmental sustainability.

UNIT VII

Environmental impact assessment and industrial effluent treatment and their disposal; pollution control in agro-based industries by agri-cycling of their effluent; environmental standards; laws for control of water and air pollution.

Suggested Readings

P.A. Vesilind. Environmental Pollution and Control.

Dictionary of the Environment, Hutchinson Pocket Book Series

Peter O. Warmer. Analysis of Air Pollutants.

M. Radojesic and V.N. Bashkin. Practical Environmental Analysis.

Werner Strans. Air Pollution Control (I-Iii).

J.O. Nariagu. Elements in the Environmental Series (Cu, Zn, Hg, Pb).

W.J. Cooper. Chemistry in Waste Reuse.

Nebel. Environmental Sciences.

Santra, S.C. 2001. Environmental Sciences, New Central Book

Ian L. Pepper Charles P. Environmental and Pollution Science.

WST 503 SOIL WATER PLANT ENVIRONMENT SYSTEM (2L+1P) I

Objective

To enable the students to study the interactive relationship among soil, water, plant and the environment in relation to the movement of water into soil, its intake by the plants and its release in the environment.

UNIT I

Introduction to Soil-Water-Plant-Environment System, Soil characteristics in relation to profile and soil horizon, soil system and basic properties of soil water potential, its various components and method of their measurements.

UNIT II

Movement of water in soils and its measurement, soil characteristics and properties in relation to irrigation, Plant water relations and role of water in plants, water loss through transpiration and factors affecting it.

UNIT III

Plant water relations and role of water in crop evapo-transpiration, its measurement and the factors influencing it, Water stress in plants and its effect on growth, quality and yield.

UNIT IV

Water relationship of cell and whole plant, Water and ion uptake by plants and its movement mechanism, Solute content and its movement.

UNIT V

Weather parameters influencing soi-water-plant relations and its measurements, climate characterization/Agroclimatic zoning and indices, introduction to microclimate/macroclimate in crops.

Practicals

Determination of soil texture and bulk density; Determination of field capacity; Determination of soil moisture characteristics curve; Determination of hydraulic conductivity; Determination of infiltration rate; Measurement/monitoring of soil temperatures, RH, wind velocity, rain, evaporation, sunshine, dew, solar radiation etc.; Determination of matric potential; Determination of RWC, LAI, LWP, SDI etc.

Suggested Readings

Ghildyal, B.P. and Tripathy, R.P. 1987. *Fundamental of Soil Physics.* Wiley Eastern.

Slatyor, O.P. 1967. *Plant Water Relationship.* Academic Press.

WST 504 / AG 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT (3L+1P) II

Objective

To teach the basic principles of water management and practices to enhance water productivity.

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil-plant-atmosphere continuum, soil water movement in soil and plants, transpiration, soil-water-plant relationships, water absorption by plants, plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; micro-irrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of crops and cropping systems, management of soil moisture stress and plant growth, strategies of using limited water supply, quality of irrigation water and management of saline water for irrigation, water-use efficiency.

UNIT V

Water stress – deficit and excess, its effect on growth and development, water stress injury and resistance, management of water stress through soil and crop manipulations, excess of soil water and plant growth; water management in problem soils.

UNIT VI

Drainage – concept and classification. Field drainage systems with special emphasis on crop production and soil salinity. Inter-relationship of drainage with cropping patterns and types of farming. Drainage requirement of crops and methods of field drainage, their layout and spacing.

UNIT VII

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practicals

Measurement of soil water potential by using tensiometer, and pressure plate and membrane apparatus. Preparation of soil-moisture characteristics curves. Water flow measurements using different devices. Determination of irrigation requirement and irrigation efficiency. Determination of infiltration rate, saturated/unsaturated hydraulic conductivity. Estimation of drain spacing under surface and sub-surface method. Soil moisture constants and measurement. Measurement of evapo-transpiration and water requirement of crops. Water management experiments – planning, conduct, recoding of data and interpretation.

Suggested Readings

Lenka, D. 1999. Irrigation and Drainage, Kalyani Publ.

Michael, A.M. 1978. Irrigation – Theory and Practice, Vikas Publ.

Paliwal, K.V. 1972. Irrigation with Saline Water, IARI, Monograph, New Delhi.

Panda, S.C. 2003. Principles and Practices of Water Management. Agrobios.

Prihar, S.S. and Sandhu, B.S. 1987. Irrigation of Food Crops – Principles and Practices, ICAR.

Reddy, S.R. 2000. Principles of Crop Production. Kalyani Publ.

Singh, Pratap and Maliwal, P.L. 2005. Technologies for Food Security and Sustainable Agroculture. Agritech. Publ.

WST 505 SOIL AND WATER CONSERVATION AND SEDIMENT TRANSPORT (3L +0P) I

Objective

To acquaint and equip the students with the process of land degradation due to soil erosion and its conservation, including design of structures and sediment transport in river beds and its accumulation in reservoirs.

Theory

UNIT I

Concept of soil and water conservation, relevance of soil and water conservation in agriculture. Problems caused by soil erosion, factors affecting soil erosion.

UNIT II

Types of soil erosion, mechanics of water erosion, factors affecting water erosion, moisture stress and excess, effect of land preparation and cultivation practices on soil erosion. Layout and planning soil erosion control measures. Erosivity and erodibility, Measurement of soil erosion. Hydraulic jump and energy dissipater for erosion central structures;

UNIT III

Design of soil conservation structures, farm ponds and temporary storage reservoirs, drop structures, chute spillways. Aforestation and associated agronomic practices, role of soil and water conservation work-river valley projects, Soil Conservation Department, CADA, etc. Flood control and stream bank protection measures

UNIT IV

Sediment yield and transport, estimation of transported sediment, effective life of dams and water detention structures, multipurpose storage zones, reservoir yield and capacity, determination life of multipurpose reservoirs, erosion of water conveyance systems, designs of channels for erosion control, tractive or face theory, maximum permissible velocity.

Suggested Readings

Garde, R.J. and Ranga Raju, K.G. 1977. *Mechanics of Sediment Transport and Alluvial Stream Problems.* Willey Eastern.

Gurmel, Sing *et al.*1994. *Manual of Soil and Water Conservation Practices.* Oxford & IBH.

Hudson, N. 1971. *Soil Conservation.* B.T. Batsford Ltd.

Murthy, V.V.N. 1998. *Land and Water Management Engineering.* Kalyani.

WST 506 HYDROLOGY AND WATERSHED MANAGEMENT (3L + 1P) III

Objective

To equip the students with the hydrologic processes, analysis hydrologic data for designing various structures, management of water resources through community participation and other aspects pertaining to the holistic development of the area.

Theory

UNIT I

Hydrologic process and systems; hydrologic problems of small watersheds precipitation and runoff and ground water flow, data generation analysis and reduction, estimation and interpretation, gauging and instrumentations. Hydrologic problems of small watershed, hydrologic characteristics of watersheds measurement and analysis of hydrologic parameters, rainfall-runoff, stream flow measurement and analysis of data, hydrograph theory, hydrograph, separation and use, unit hydrograph flood routing.

UNIT II

Concept of watershed, characterization, priority watershed, need for integrated approach, Integrated watershed management - importance and relevance for holistic development, problem identification,

deterioration and priority concept. Land and water degradation, land capability and suitability classification. Database generation and management, Impact evaluation and assessment. Watershed resources appraisal, watershed survey, data requirement,

UNIT III

Community participation, rationale, potential need, constraints, mobilization process, empowerment of panchayats, peopl's organization, management of common property resources, etc.Role of NGOs and political will and support; Water harvesting technique small storage and traditional methods.

UNIT IV

Watershed management programme in the country-overview, planning and guidelines success and failures, economic evaluation and environmental assessment, watershed policy formulation for planning and management.

Practicals

Delineation of watersheds, watershed yield and estimation of runoff from watershed, analysis of hydrological data, design of soil and water conservation structures, watershed survey watershed management planning

Suggested Readings

Chow, V.T., David, M. and Mays, L.W. 1988. Applied Hydrology. McGraw Hill.

Das, Ghanshyam 2000. *Hydrology and Soil Conservation Engineering*. Prentice Hall.

Tideman, EM. 1996. *Watershed Management*. Omega Scientific Publ.

WST 509 ECONOMIC SOCIAL AND INSTITUTIONAL ISSUES IN WATER RESOURCES MANAGEMENT (3L+0P) I

Objective

To equip the students with the various principles of economics and use in water resources management for determining the optimal level of crop production at minimal cost, economic and financial function of irrigation water charges and market price determination of irrigation water

Theory

UNIT I

Principles of economics and their applications in water resources management. Factors of production - Determination of optimal level of production and factor application – Optimal factor combination and least cost combination of production – THEORY of product choice; selection of optimal product combination.

UNIT II

Water resources pricing: Economic and financial functions of irrigation water charges – Market price determination of irrigation water – Price elasticity – Charging vehicle

UNIT III

Economic appraisal of irrigation programmes – Feasibility criteria – Assessment of costs and benefits and discounting techniques – Internal rate of discount.

UNIT IV

Policy approaches for efficient on-farm water utilization: Equity and efficiency in water distribution. – Institutional framework in canal command area and watershed areas – Organizations, their roles and functions – Water user's associations in canal command areas and Common Guidelines for watershed management – Banking and financing mechanism in water resources management.

UNIT V

Interstate water disputes – Constitutional provisions – Water laws, water rights and managing conflicts.

Suggested Readings

Economics of water resources planning L. Douglas James and Robert R. Lee. McGraw-Hill Book Company. 1971.

Modern Microeconomics, A. Koutsoyiannis, Macmillan Press Ltd., 1979.

The Economics of irrigation lan Carruthers and Colin Clark Liverpool University Pres, 1981.

WST 510/ SSAC 510/AG 510 MANAGEMENT OF PROBLEM SOILS AND WATERS (3L+1P) I

Objective

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

Theory

UNIT I

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept of problematic soils, and factors responsible

UNIT II

Morphological features of saline, sodic and saline-sodic soils; characterization of salt-affected soils – soluble salts, ESP pH, physical, chemical and microbiological properties.

UNIT III

Acid soils – nature of soil acidity, sources of soil acidity, effect on plant growth, lime requirement. Management of acid soils, biological sickness of soils and its management.

UNIT IV

Management of saline and sodic soils; salt tolerance of crops – mechanism and rating; monitoring of soil salinity in the field; management principles of sandy, clayey, red lateritic and dry land soils.

UNIT V

Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

UNIT VI

Quality of irrigation water; management of brackish water for irrigation, salt balance under irrigation characterization of brackish waters.

UNIT VII

Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, ways to overcome the effect of salt stress through soil and crop manipulations.

Practicals

Characterization of acid, acid sulfate, salt-affected and calcareous soils. Determination of Cations (Na, K, Ca and Mg) in ground water and soil samples. Determination of anions(Cl, SO_4, CO_3 and HCO) in ground waters and soil samples. Determination electrical conductivity and gypsum requirement of salt-affected soils. Determination of soil pH and lime requirements of acid soils. Determination of salt stress/injury on plants under laboratory conditions. Visit to salt-affected/ acid soil area (CSSRI/CPRI)

Suggested Readings

Agarwal, R.R., Yadav, J.S.P. and Gupta R.N. 1982. *Saline and Alkali Soils of India*, ICAR, New Delhi

Bear, F.E. 1964. *Chemistry of the Soil*, Oxford and IBH, New Delhi.

Bolt, G.H. and Bruggenwert, M.G.M. 1978. *Soil Chemistry*, Elsevier, Amsterdam. The Netherlands.

Goswami, N.N., Rattan, R.K., Dev, G., Narayanasamy, G., Das, D.K., Sanyal, S.K., Pal, D.K. and Rao, D.L.N. 2009. *Fundamentals of Soil Science*, Second Edition. Indian Society of Soil Science, New Delhi.

Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson, WL. 2006. *Soil Fertility and Fertilizers*. 7th Edition. Prentice Hall, New Delhi.

Jurinak, J.J. 1987. *Salt-affected Soils*. Department of Soil Science and Biometeorology. Utah State Univ., Ames, USA.

Mahapatra, I.C., Mandal, S.C., Mishra, C., Mitra, G.N. and Panda, N. (Technical Editors). *Acid Soils of India*. ICAR, New Delhi.

USDA Handbook No. 60. 1954. Diagnosis and improvement of Saline and Alkali Soils. Oxford and IBH, New Delhi.

WST 511 SOIL AND WATER QUALITY AND IRRIGATION MANAGEMENT (2L+IP) II

Objective

To get the student acquinted with the various soil and water quality problems and their extent in India, their impact on crop production and their treatment through monitoring and analyzing.

Theory

UNIT I

Nature of problems, soils-type and extent in India; physical, chemical, topographical and hydrological assessment of magnitude of the problems.

UNIT II

Impact on crop production. Identification and adoption of appropriate water management technologies. Case studies of water-logging and soil salinity problem areas. Water quality classification; sources of water pollution; water quality monitoring; sampling strategies and techniques;

UNIT III

Water quality impacts on crop performance; irrigation with poor quality water. Interaction between water and soil constituents. Salute transport. Treatment of effluents for irrigation

List of Practicals

The nature and the extent of soil and water quality problems in India, analysis of water and soil samples to determining their suitability for agriculture, identification for adoption for various water management technologies in relation to this problem, determining the salute transport mechanism.

Suggested Readings

Larry W Mays 1996. *Water Resources Handbook.*McGraw Hill.

Matcalf and Eddey 1994. *Wastewater Treatment Engineering and Reuse.* John Wiley

Soli J Arceivala 1998. *Wastewater Treatment for Pollution Control.* Tata McGraw-Hill.

WST 530/AP 530 FUNDAMENTALS OF METEOROLOGY AND CLIMATOLOGY (3L+1P) I

Objective

To impart theoretical and practical knowledge about basic physical processes in the atmosphere with an aim to apply in agriculture.

Theory

UNIT I

Atmosphere and its constituents, weather and climate; meteorology and climatology, meteorological elements, instruments for measurement of meteorological elements, meteorological observatory, weather satellites, websites of meteorological organizations – IMD, NCMRWF, IITM, WMO.

UNIT II

Sun and earth; seasons, solstices and equinoxes, solar radiation and laws of radiation, solar constant; radiation receipt on earth surface, heat balance of the earth and atmosphere.

UNIT III

Variation of pressure and temperatures with height; hydrostatic equation, atmospheric moisture; vapour pressure; saturation deficit; psychometric equations, lapse rates, atmospheric stability, tephigram, potential temperature.

UNIT IV

Climatic controls, seasonal distribution of climatologically elements (radiation, temperature, pressure and precipitation) over latitudes.

UNIT V

Clouds and their classification, precipitation processes; artificial rain making, thunderstorms and dust storms; haze, mist, fog and dew, introduction to evapotranspiration,

UNIT VI

Pressure gradient; coriolis force; cyclones and anti-cyclones, local wind systems; land and sea breeze circulation, mountain and valley winds, air masses and fronts,

UNIT VII

Weather charts, forecasting methods – short, medium and long range forecasting techniques, numerical weather prediction.

UNIT VIII

Climatic classification: Koppen and Thornthwaite systems, agroclimatic indices, agroclimatic zones; different agro ecological zones for India.

UNIT IX

Climatology of India; monsoons, rainfall variability; El Nino, La Nina and ENSO, disastrous weather events in different regions, drought climatology and drought indices, climate change and global warming, impacts of climate change on agro-ecosystems.

Practicals

Meteorological observatory, meteorological instruments, recording of weather parameters, daily, weekly and monthly means, meteorological websites, standard meteorological weeks and Julian days, classification of clouds, climatic normal, climatic chart, low and high pressure systems.

Suggested Readings

Barry, R.G. and Chorley, R.J. 1982. *Atmosphere Weather and Climate*. ELBS (UK)

Critchfield, H.J. 1982. *General Climatology*. Prentice Hall of India (New Delhi).

Das, P.K. 1995 . *The Monsoon*. NBT (New Delhi)

Ghadekar, S.R. 2001. *Meteorology*. Agromet Publishers (Nagpur)

Ghadekar, S.R. 2002. *Practical Meteorology*. Agromet Publishers (Nagpur)

Menon, P.A. 1989 . *Our Weather*. NBT (New Delhi)

Petterson, S. 1958. *Introduction to Meteorolog*y. McGraw Hill (New York).

Trewartha, G.T. 1954. *An Introduction to Climate*. McGraw Hill(New York).

Journals

Journal of Climate

International Journal of Climatology

Mausam

Vayumandal

Weather

WST 600 WATER RESOURCE MANAGEMENT-II (2L+1P) III

Objective

To expose the students to the irrigation development in India, irrigation water distribution practices for water resource utilization analysis in water resource management planning including benefit costs etc.

Theory

UNIT I

Water Resources of India (Sources, current state of development, Potential, State wise distribution), Natural Resource base for Irrigation (Rainfall, Soil & Land, Crop water requirement)

UNIT II

Irrigation development in India, surface/ground water, Irrigation water distribution practices in India, Warabandi system

UNIT III

Introduction to systems analysis in water resources planning and management, OBJECTIVE functions, benefits, cost, decision variables, constraints etc., Techniques used for systems analysis/

Optimization: Linear programming(LP)/Dynamic Programming/Simulation and their application in water resources management

UNIT IV

Expert systems and Decision Support Systems (DSS) in Water Resources Management, Case Studies of Application of GIS and Remote Sensing in Water Resources

UNIT V

Conjunctive use of canal and ground water : Case studies, Water logging and salinity management and modelling , Poor quality water management for agriculture

Practicals

Data collection on water statistics, Irrigation Water distribution practices in India, Formulations of Systems Analysis Problems, Formulation and solutions of LP problems using softwares, Development of simulation models, expert systems, DSS for water resources management (methodology), Estimation of water quality parameters.

Suggested Readings

Larry, W.M. 1996. *Water Resources Handbook.* McGraw-Hill.

Loucks, D.P. *et al.*1981. *Water Resource System Planning and analysis.* Prentice Hall.

Rao, S.S. 1978. *Optimization THEORY and Applications.* Wiley Eastern.

WST 601 CROP WATER REQUIREMENT & IRRIGATION PLANNING (2L+1P) III

Objective

This course is imperatively needed for effective planning of water utilization in crop production.

Theory

UNIT I

Introduction to the course, land use capability and soil and land irrigability assessment, concepts of crop water requirements, irrigation planning and irrigation scheduling, irrigation planning factors, factors affecting irrigation water requirement

UNIT II

Introduction to Methods of estimation of reference evapo-transpiration, crop response function

UNIT III

Estimation procedure of ET (both reference and actual), water availability and its significance in irrigation management, various methods of estimation of reference evapo- transportation and crop consumptive use.

UNIT IV

Concept of field water balance, various components of field water balance their estimation, both by analytical and empirical methods.

UNIT V

Application of concepts of cropping pattern and cropping intensity, crop planning in relation to changing scenario of input availability, crop response function to irrigation, irrigation scheduling to crops and irrigation methods.

UNIT VI

Estimation of seasonal and annual water requirement of various field crops, progressive peak and seasonal consumptive water use and their significance in operation of irrigation projects, application of simulation model for irrigation planning and scheduling.

Practicals

Irrigation scheduling criteria, estimation of crop water requirement, crop water use efficiency, irrigation water use efficiency. Estimation of evapo-transpiration (reference and actual by field technique for a specific period). Procedure for estimation of actual crop evapo-transpiration of different crops using the concept of trickle methods of irrigation. Application of Irrigation scheduling information system-computer model in irrigation planning and scheduling with some case study. Application of CROPWAT.

Suggested Readings

Doorenbos, L. and Pruih, W.O. 1975. *Crop Water requirement*. FAO Irrigation and Drainage Paper No. 24 *(FAO-24).*

FAO 1998. Crop Evapo-transpiration- Guidelines for computing crop water requirement. Irrigation and Drainage Paper no. 56.

Michael, A.M. 1986. *Irrigation THEORY and Practices*. Vani Education Books. 801 P., New Delhi.

Singh, Man and Kandpal, B.K. 1998. Planning Irrigation Schedule with IRSIS for Cotton crop. *J. of Indian Water Reso. Society.* Vol. 18(4) No. 1 pp.23-28.

WST 603 ECONOMIC ANALYSIS OF WATER USE (3L+0P) II

Objective

To make the students aware of the econometric research in the field of water utilization and developing various econometric models and their validation.

Theory

UNIT I

Econometric models. Introduction and stages in econometric research, properties of an econometric model.

UNIT II

Basic two variable regression, the Ordinary Least Square Method, assumptions, estimation and interpretation – extension to multivariable models, multiple regression estimation and interpretation.

UNIT III

Violation of assumptions – identification, consequences and remedies for multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches – model misspecification.

UNIT IV

Linear Programming. Introduction, graphic solution to problems, formulation of problems. Simplex method – solving profit maximization and cost minimization problems, variable resource and price programming.

Suggested Readings

Economics of Irrigation; Ian Carruthers and Colin clark Liverpool University Press, 1981.

Econometric Methods, J. Johnston, McGraw-Hill Book Company, 1991

Matrices and Linear Programming with application, Toshinori Munakala, Holden-day, inc. 1979.

THEORY of Economatics; A Koutsoyiannis, Macmillan Education Ltd., 1992.

WST 607 ENVIRONMENTAL IMPACT ASSESSMENT OF IRRIGATION PROJECTS

(3L+0P) III

Objective

To get the students acquainted with the environmental impact of water resource storage facilities and their assessment, regulation, operation and maintenance through various tools, models and techniques.

Theory

UNIT I

Introduction to the concept of EIA; Environmental impact of dams and reservoirs for irrigation water supply. Environment Impact Assessment (EIA) protocols, guidelines, regulation and policies for construction of dams and reservoirs in India. Case studies of use of EIA in addressing the impact of irrigated agricultural environment and rural development activities in India.

UNIT II

Agricultural nonpoint sources of pollution, process of salinization and desalinization, land reclamation measures, land remediation through subsurface drainage technology, leaching of nitrate and phosphorous beyond crop root zone, Indicators of biological health of the soil, final assessment of the irrigable class of the land for sustainable use.

UNIT III

Use of geospatial tools viz. GIS,RS, AND GPS and modeling techniques for impact assessment of irrigation projects. Assessment of surface runoff, pollutant load and sediment yield from reservoir catchments and quality regulations. Impact of agricultural practices on surface and ground water pollution in the catchment area. Preparation of digital data base of the irrigated canal commands. Use of geostatistical techniques for generation of spatio-temporal variability maps and delineation of vulnerable zones as per EIA guidelines. Preparation of EIA reports on irrigation and water resources projects.

UNIT IV

Social benefit-cost analysis of environmental impact of irrigation projects. Rationale and significance. Objective and measures of benefits – aggregate consumption, income redistribution, self reliance and merit wants. Direct and indirect benefits and costs and their measurement. EIA under risk and uncertainty.

Suggested Readings

Dunne, T. and Leopold, LB. Water in Environmental Planning

Environmentally Sound Water Management (Ed.) Tharh, NC and Biswas, AK. Oxford Uni. Press.

Important Aspects of River Valley Project No. 4.

Water and the Environment. FAO Paper No. 8

WST 608 DIAGNOSTIC ANALYSIS AND PERFORMANCE EVALUATION OF IRRIGATION PROJECTS (1L +3P) II

Objective

To expose the students to the basic problems in irrigation projects and equip them with the analysis of data to diagnostic approach in farmer's field to design manage and operate irrigation systems both at farm level and command levels.

Theory

UNIT I

Definition, objectives, activities and basic aspects of diagnostic analysis. Fundamentals of conceptual framework for performance evaluation of irrigation project.

UNIT II

Study and measurement of performance parameters under different fertility levels. Efficient utilization of irrigation water. Hydraulics of water advance and recession. Design of surface irrigation methods, evaluation of irrigation methods.

UNIT III

Operational management of irrigation and Drainage networks. Participatory irrigation water management. Evaluation of irrigations projects in relation to basic objectives. Equitable water distribution.

UNIT IV

Socio-economic, political and organizational implications in the management of irrigation systems. Pricing of irrigation water Case studies.

List of Practicals

Volume and mass relationship of soil constituents, soil texture and structure, movement of water into soil, determination of soil moisture coefficients, water and irrigation requirements, irrigation efficiencies, operational management of irrigation projects and socio-economic survey of framers, design and evaluation of irrigation methods, evaluation of irrigation project, diagnostic analysis in farmers fields and remedial measures for improving irrigation management at the farms.

Suggested Readings

Finkel HJ. 1983. *Handbook of Irrigation Technology.* Vols. I-II. CRC Press

Ivan E Henk. 1951. *Irrigation Engineering.* Vol. I. John Wiley & Sons.

Karmeli D. Peri G & Todes M. 1985. *Irrigation Systems: Design and Operation.* Oxford Univ. Press.

WST 611 PRESSURIZED IRRIGATION SYSTEM DESIGN (2L+1P) II

Objective

To introduce design and planning procedures for sprinkle and trickle irrigation system; Special attention is given to modern irrigation equipment, system and automation and to energy saving measures.

Theory

UNIT I

Sprinkler irrigation: an overview, types of systems, system components, design objective, uniformity, adequacy and efficiency of application.

UNIT II

Design of different types of sprinklers; Design of pipelines, laterals, manifold, submain and mains; Design of traveler sprinkler system, layout, hose selection, gun sprinklers

UNIT III

An introduction of trickle or drip irrigation, overview of types of system, various components of trickle systems, clogging and filtration, system flushing and maintenance.

UNIT IV

Trickle / drip irrigation planning factors, emitter selection and design criteria,

Trickle system design strategy and trickle lateral design.

UNIT V

Trickle manifold design, trickle system design synthesis and pressurized irrigation system selection.

Practicals

Design of pipelines, laterals, manifold, submain and mains of drip and sprinkler irrigation systems. Determination of uniformity coefficients, developing criteria for evaluating pressurized irrigation system.

Suggested Readings

Benami, A. and Often, A. 1983. *Irrigation Engineering*, Haifa Israel: Irrigation Engineering Scientific Publication (IESP).

Cuenca, R.H. 1989. *Irrigation System Design*, Englewood Cliffs, New Jersey: Princeton Hall.

Hillel, D. (Editor). 1982. *Advances in Irrigation*, New York. Academic Press.

Keller, J. and Bliesner, Ron D. 1990. *Sprinkle and Trickle Irrigation*.

Michael, A.M. 1978. *Irrigation Theory and Practices*, New Delhi, Vikas Publishing House.

Nakayama, F.S. and Bucks D.A. (Eds) 1986. *Trickle Irrigation for Crop Production. Design, Operation and Management*.

WST 614 IRRIGATION HYDRAULICS (2L+1P) III

Objective

To equip the students with the development of various models in surface irrigation hydraulics, using basic infiltration equations movement and disappearance of water from the surface through infiltration and finding numerical solution to various problems in irrigation hydraulics.

Theory

UNIT I

Evolution of surface irrigation methods, selection of a particular irrigation method, Fundamentals of surface irrigation hydraulics,

UNIT II

Infiltration equations and key parameters, irrigation performance parameters

UNIT III

Flow processes in basin, border and furrow irrigation and flow governing equations, The hydrodynamic models and numerical solution, The zero-inertia models and numerical solution

UNIT IV

The kinematic-wave models and numerical solution, The volume balance models and numerical solution, One and two-dimensional surface irrigation models

UNIT V

Surface irrigation design and operation software, Pipe hydraulics in pressurized irrigation network, Total head, friction head loss estimation in pressurized irrigation.

Practicals

Development of various criteria for selecting a particular method, study of the various processes in basin, border and furrow irrigation through governing equations, developing irrigation designs and operation software, estimation of head loss due to friction in pressurized irrigation pipes.

Suggested Readings

FAO 1989. Guidelines for Designing and Evaluating Surface Irrigation Systems. FAO Irrigation and Drainage paper 45.

Finkel, H.G. 1983. *Hand book of Irrigation Technology*. Vol. I-II. CRC Press.

Ivan E. Henk. 1951. *Irrigation Engineering*. Vol. I. John Wiley & Sons.

Karmeli, D., Peri, G. and Todes, M. 1985. *Irrigation Systems: Design and Operation*. Oxford University Press.

WST 615 WATER MANAGEMENT TECHNOLOGIES IN RAINFED AGRICULTURE

(2L+1P) III

Objective

To expose the student with the various problems of water management and their solution for increasing agriculture production in rainfed areas, agriculture production as climatic change and the characterization and rain\fed areas, development and use of techniques and mathematical models.

Theory

UNIT I

Prospects of rainfed agriculture, climate change and its impact, characterization and delineation of rainfed areas, moisture stress and low productivity, concepts of blue, green, gray, black, fossil water, rainfall analysis, dry and wet spells, drought, Huff curves.

UNIT II

Techniques and mathematical models for quantification of runoff, use of GIS, RS, DSS, GPS tools and hydrological models in assessment of surface & ground water resources, uncertainty analysis, up scaling/down-scaling approaches, modified Mitscherlich equation, modern tools and crop models in water management.

UNIT III

Resource conservation techniques, improving water use efficiency, conservation tillage, water harvesting, irrigation techniques, mulches and evaporation suppressants, integrated nutrient management.

UNIT IV

Watershed development and integrated watershed management, case studies, crop diversification, farming system approach, alternate land use systems.

UNIT V

Extension strategy, RRA, PRA and PAR, economic issues, institutions and water users associations, PIM and rotational water supply schemes, research and developmental needs, policy issues, National Rainfed Area Authority.

Practicals

Characterization and delineation of rainfed areas, rainfall analysis, dry and wet spells, drought, Huff curves, techniques and mathematical models for quantification of runoff, use of GIS, RS, DSS, GPS tools and hydrological models in assessment of surface & ground water resources, uncertainty analysis.

Suggested Readings

De Mess, M.N. 1004. *Fundamental of Geographic Information System.* John Wiley & Sons.

Lille, Sand T. and Kaiffer, R. 1987. *Remote Sensing and Image Interpretation.* John Wiley & Sons.

Tideman, E.M. 1996. *Watershed Management*. Omega Scientific Publ.