



**Department of Irrigation and Drainage
Engineering
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)**



Master's Programme in Irrigation and Drainage Engineering

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1	Major	20
2	Minor	09
3	Supporting	05
4	Seminar	01
5	Research	20
	Total credits	55
	Non credit compulsory courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major Subjects (Min. 20 credits)			
1.	IDE 501*	Open Channel Flow	3(3+0)
2.	IDE 502*	Design of Pressurized Irrigation Systems	2(1+1)
3.	IDE 503*	Agricultural Drainage Systems	3(2+1)
4.	IDE 504*	Ground Water Engineering	3(2+1)
5.	IDE 505	Crop Environmental Engineering	2(2+0)
6.	IDE 506	Design of Pumps for Irrigation and Drainage	2(2+0)
7.	IDE 507	Flow through Porous Media	2(2+0)
8.	IDE 508	Water Resources System Engineering	3(3+0)
9.	IDE 509	GIS and Remote Sensing for Natural Resources Management	3(2+1)
10.	IDE 510	Design of Surface Irrigation System	2(1+1)
11.	IDE 511	Introductory Hydroinformatics	3(2+1)

12.	IDE 512	Aerodynamics of Evapotranspiration	3(2+1)
13.	IDE 513	Systems Management in Green House	3(2+1)
14.	IDE 514	Water Quality and Pollution Control	3(2+1)
15.	IDE 592*	Special Problem	1(0+1)
16.	IDE 595#	Industry/ Institute Training	NC

B) Minor Subjects (Min. 9 credits)

1.	MATH 501	Higher Engineering Mathematics	3(2+1)
2.	MATH 502	Methods of Numerical Analysis	2(1+1)
3.	MATH 503	Advance Calculus for Engineers	2(2+0)
4.	STAT 511	Statistical Methods for Applied Science	3(2+1)
5.	STAT 512	Experimental Design	3(2+1)
6.	SWCE 504	Watershed Management and Modeling	3(2+1)
7.	SWCE 507	Land Development and Earth Moving Machinery	2(2+0)
8.	SWCE 509	Fluvial Hydraulics	3(2+1)
9.	SWCE 510	Statistical Hydrology	3(3+0)
10.	SWCE 511	Dams and Reservoir Operations	3(2+1)

C) Supporting Courses (Min. 5 credits)

1.	AE 502	Similitude in Engineering	3(2+1)
2.	BSCT 501	Computer Graphics	3(2+1)
3.	MATH 504	Neural Network and its Applications	3(2+1)
4.	FMPE 521	Computer Aided System Design	2(0+2)
5.	AE 503	Applied Instrumentation	3(2+1)
6.	BSCT 502	Computer Languages for Engineering Applications	3(1+2)

D) Seminar (1 credit)

1.	IDE 591	Seminar	1(0+1)
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E) Master's Research (20 credits)

1.	IDE 599	Master's Research	20 (0+20)
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F) Non Credit Compulsory Courses

1.	PGS 501	Library and Information Services	1(0+1)
2.	PGS 502	Technical Writing and Communications Skills	1(0+1)
3.	PGS 503 (e-Course)	Intellectual Property and its Management in Agriculture	1(1+0)
4.	PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)
5.	PGS 505 (e-Course)	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)
6.	PGS 506 (e-Course)	Disaster Management	1(1+0)

* Compulsory

#Minimum of three weeks

Course Content

A) Major Subjects

IDE- 501* **Open Channel Flow** **3(3+0)**

Theory:

UNIT I

Open channel and their properties, energy and momentum, critical flow computation and application.

UNIT II

Uniform flow; gradually varied flow theory and analysis, methods of computation.

UNIT III

Practical problems such as design of transitions, flow passing Islands etc. spatially varied flow, rapidly varied flow.

UNIT IV

Hydraulic jump and its use as energy dissipator, flow through channel of non-linear alignment and flow through non-prismatic channel sections.

UNIT V

Unsteady flow, gradually varied unsteady flow and rapidly varied unsteady flow.

Suggested Books:

Chaudhry M. H. 1993. Open Channel Flow. Prentice Hall.

Chow VT. 1959. Open Channel Hydraulics. Mc-Graw Hill.

Henederson FM. 1966. Open Channel Flow. MacMillan.

IDE- 502* **Design of Pressurized Irrigation Systems** **2(1+1)**

Theory:

UNIT I

Preliminary design criteria of pressurized irrigation systems (sprinkler and micro irrigation), pipe line hydraulics of sprinkler and micro irrigation systems, soil water plant relations for pressurized irrigation systems

UNIT II

Sprinkler irrigation system: Types of sprinkler systems, sprinkler irrigation planning factors, uniformity and efficiency, layouts, lateral design, main delivery system design, pressure requirement of sprinkler system, pump and power unit selection.

Special systems: traveling sprinkler system, central pivot system, raingun system

UNIT III

Trickle irrigation: types and components, trickle irrigation planning factors, emitter selection and design criteria, trickle system design strategy, lateral design, manifold design, system requirement, pressure calculation and pump selection

Special systems: microsprinkler, bubbler and subusurface porous pipe

UNIT IV

Water quality for pressurized irrigation systems, fertigation schedule and devices, filtration process and equipment design, automation in pressurized irrigation systems

UNIT V

Evaluation procedures for pressurized irrigation systems, economic analysis of pressurized irrigation systems.

Practical:

Design of sprinkler irrigation system
Design of drip irrigation system
Establishment of different relationships between design and performance parameters of sprinkler irrigation system
Establishment of different relationships between design and performance parameters of trickle irrigation system
Evaluation of sprinkler irrigation system
Evaluation of trickle irrigation system
Fertigation and filtration equipments

Suggested Books:

Keller, J. And Bliesner, D. 1990. Sprinkler and Trickle Irrigation. An avi book published by Van Nostrand Reinhold, Newyork
Nakayama, F.S. and Bucks, D.A. 1986. Trickle irrigation for crop production. Elsevier publishers.
Karmeli D, Peri G & Todes M. 1985. Irrigation Systems: Design and Operation. Oxford Univ. Press.
Pillsbury A.F. 1972. Sprinkler Irrigation. FAO Agricultural Development Paper No. 88.
Sivanappan RK, Padmakumari O & Kumar V. 1987. Drip Irrigation. Keerthy Publ. House.
Sivanappan RK. 1987. Sprinkler Irrigation. Oxford & IBH.
Choudhary M.L. and Kadam. U.S. 2007. Micro-irrigation for cash crops. Westville Publishing House, 47, B-5 Paschim Vihar, New Delhi-110 065
Mane M.S., Ayare B.L. and Magar S.S. 2006. Principles of Drip Irrigation System. M/s. Jain Brothers, New Delhi.
Mane M.S., and Ayare B.L. 2007. Principles of Sprinkler Irrigation System. M/s. Jain Brothers, New Delhi.

IDE-503	Agricultural Drainage Systems	3(2+1)
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Theory:

UNIT I

Theories and applications of surface and sub-surface drainage, steady state, unsteady state drainage equations for layered and non-layered soils, horizontal sub-surface drainage.

UNIT II

Principle and applications of Earnst, Glover Dumm, Kraijenhoff-van-deleur equations.

UNIT III

Salt balance, leaching requirement and management practices under drained conditions

UNIT IV

Design of different components of sub-surface drainage systems, theories of vertical drainage, and multiple well point systems

UNIT V

Disposal of drainage effluents, Management of drainage projects of waterlogged and saline soils, case studies.

Practical:

Measurement of in-situ hydraulic conductivity, estimation of drainage coefficient and leaching requirements, Delineation of waterlogged areas through isobar, isobath and topographic maps. Design of surface and subsurface drainage systems, design of filter and envelop material

Suggested Books;

Battacharaya AK & Micheal AM. 2003. Land Drainage. Vikas Publ.

Clande Ayres & Daniel Scoates A.E. 1989. Level Drainage and Reclamation. McGraw Hill.

Kadam U.S., Thokal R.T., Gorantiwar S.D. and Powar A.G. 2007: Agricultural Drainage Principles and Practices. Westville Publishing House, 47, B-5 Paschim Vihar, New Delhi-110 065

Luthin JN. 1978. Drainage Engineering. Wiley Eastern.

Ritzema HP. (Ed.). 1994. Drainage Principles and Applications. ILRI

Roe CE 1966. Engineering for Agricultural Drainage. McGraw Hill

IDE 504**Ground Water Engineering****3(2+1)**

Theory:**UNIT I**

Properties affecting groundwater storage and movement, groundwater balance studies.

UNIT II

Well hydraulics, two dimensional flow, steady and unsteady state flow in confined, unconfined and semi-confined aquifers, steady flow in sloping aquifers, partial penetrating wells. Analysis of multi-aquifers.

UNIT III

Flow analysis in interfering wells. Pumping tests and determination of aquifer parameters.

UNIT IV

Groundwater modeling for water resources planning.

UNIT V

Techniques for groundwater recharge.

Practical:

Water table contour maps and determination of groundwater flow, estimation of aquifer characteristics, problems on non leaky and leaky aquifers, analysis of pumping test data; Computation of interference of wells; groundwater computer simulation models.

Suggested Books;

- Boonstra J & de Ridder NA. 1981. Numerical Modeling of Groundwater Basins. ILRI.
 Domenico PA. 1972. Concept and Models in Groundwater Hydrology. McGraw Hill.
 Hantush MS. (Ed.). 1964. Advances in Hydro Sciences. Vol. I. Academic Press.
 Harr ME 1990. Ground Water and Seepage. Wiley Eastern.
 Huisman L. 1972. Groundwater Recovery. MacMillan.
 Polubarinova Kochina P Ya 1962. Theory of Ground Water Movement. Princeton Univ. Press.
 Raghunath HM. 1992. Ground Water. Wiley Eastern.
 Todd DK. 1997. Ground Water Hydrology. Wiley Eastern.

IDE- 505	Crop Environmental Engineering	2(2+0)
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Theory;**UNIT I**

Aerial and edaphic environments for plant growth, energy and mass transfer in and above crop canopies.

UNIT II

Climatic changes and plant response to environmental stresses, evapotranspiration models. Instrumentation and techniques for monitoring plant environments.

UNIT III

Processes and aspects of growth and development, soil-root interface, root sink functions.

UNIT IV

Groundwater modeling for water resources planning.

UNIT V

Design and operation of controlled environment facilities and their instrumentation. Crop growth and yield modeling.

Suggested Books:

- Ghildyal BP & Tripathy RP. 1987. Fundamental of Soil Physics. Wiley Eastern.
 Slatyor OP. 1967. Plant Water Relationship. Academic Press.

IDE- 506	Design of Pumps for Irrigation and Drainage	2(2+0)
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Theory:**UNIT I**

Basic hydraulic design of centrifugal pump, water hammering problem in centrifugal pump.

UNIT II

Principle and performance characteristics of vertical turbine pump, submersible pump and axial flow pump and their design.

UNIT III

Non-conventional energy sources for pumping, windmills, micro turbines, solar pumps, and hydraulic ram- their selection and design criteria.

UNIT IV

Design of pumping station, techno-economic evaluation. Energy conservation measures for pumping systems.

Suggested Books:

Church AH & Jagdish Lal 1973. Centrifugal Pumps and Blowers. Metropolitan Book Co.
Michael AM & Khepar SD. 1989. Water Well and Pump Engineering. Tata McGraw Hill.
Michael AM. 1990. Irrigation Theory and Practice. Vikas Publ. House.
Modi PN & Seth SM. 2000 Hydraulic and Fluid Mechanics. Standard Book House.

IDE- 507**Flow through Porous Media****2(2+0)**

Theory:

UNIT I

Aquifer and fluid properties, forces holding water in soils, hydrodynamics in porous media and limitations of governing laws.

UNIT II

Differential equations of saturated flow, initial and boundary conditions. Dupuit and Business approximations and linearization techniques.

UNIT III

Stream functions, potential functions and flow net theory. Analysis of seepage from canals and ditches.

UNIT IV

Unsaturated flow theory, Infiltration and capillary rise flux dynamics. Hydro-dynamic dispersion in soil-aquifer system.

Suggested Books:

Harr Milton E. 1962. Groundwater and Seepage. McGraw-Hill.
Jacob Beer 1972. Dynamics of Fluid Flow in Porous Media. Elsevier.
Muskat M & Wyckoff RD. 1946. The Flow of Homogeneous Fluids through Porous Media. JW Edwards.
Patrick A Domenico & Schwartz FW. 1998. Physical and Chemical Hydrogeology. John Wiley & Sons.
Remson I, Hornberger GM & Moiz Fred J. 1971. Numerical Methods in Subsurface Hydrology. Wiley Interscience.

IDE- 508

Water Resources System Engineering

3(3+0)

Theory:

UNIT I

Concepts and significance of optimization in water resources, objective functions, deterministic and stochastic inputs.

UNIT II

Mathematical programming techniques, linear programming and its extension: gradient method, simplex method, non-linear programming classical optimization.

UNIT III

Geometric programming and dynamic programming, application of optimization techniques for water resources.

UNIT IV

Development and management including conjunctive use, crop production functions and irrigation optimization.

Suggested Books:

Larry WM. 1996. Water Resources Handbook. McGraw-Hill.

Loucks DP et al. 1981. Water Resource System Planning and Analysis. Prentice Hall.

Rao SS. 1978. Optimization Theory and Applications. Wiley Eastern.

IDE- 509

GIS and Remote Sensing for Natural Resource Management

3(2+1)

Theory:

UNIT I

Basic principles of remote sensing and sensors. Elements of photogrammetry.

UNIT II

Electromagnetic spectrum. Energy interaction with surface features, Aerial photo and satellite imagery. Photo and image interpretation

UNIT III

Principles of Geographical Information System tools, their types and capabilities, Advantages of GIS over conventional methods.

UNIT IV

Importance of ground truth establishment, GIS and remote sensing for land and water resources data collection, analysis and interpretation, Application of GIS in water and land resource development and management.

Practical:

Familiarization with remote sensing and GIS hardware, software and their principle of working, Methods of establishing ground truth, Comparison between ground truth and remotely sensed data, Application of GIS packages.

Suggested Books;

De Mess MN. 2004. Fundamental of Geographic Information System. John Wiley & Sons.

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

Sabbins F.1987. Remote Sensing Principle and Interpretation. Freeman

IDE- 510	Design of Surface irrigation system	2(1+1)
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Theory:**UNIT I**

Concepts of Irrigation; Irrigation principles, irrigation requirement, losses in conveyance, distribution and application, scheduling parameters, water budgeting, underground water conveyance system

UNIT II

Hydraulics of water advance and recession, hydraulic resistance to flow, infiltration, irrigation system performance.

UNIT III

Surface irrigation hydraulics: fundamentals, continuity equation, momentum equation. The hydrodynamic model: characteristic approach and Eulerian Integration, the zero inertia model, the kinematic wave model and the volume balance model.

UNIT IV

Design and of Border irrigation, furrow irrigation, check basin irrigation, layouts of surface irrigation systems, evaluation of surface irrigation methods.

UNIT V

Sub irrigation methods and concepts, special systems: cabligation and surge irrigation, economics of surface irrigation methods.

Practical:

Design of underground water conveyance systems
Design of border irrigation method
Design of check basin irrigation method
Design of furrow irrigation method
Evaluation of border irrigation method
Evaluation of check basin irrigation method
Evaluation of furrow irrigation method
Economics of irrigation methods
Visit to mechanized farms.

Suggested Books:

Walker, W.R. and Skogerboe, G.V. 1987. Surface irrigation: theory and Practice. Prentice-Hall Inc., Englewood Cliffs, New Jersey, USA.

Finkel H.J. 1983. Handbook of Irrigation Technology. Vols. I-II. CRC Press.

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

Michael A.M. 1990. Irrigation Theory and Practice. Vikas Publ. House

Theory:**UNIT I**

Introduction to Hydroinformatics, Need and Applications of Hydroinformatics. Various tools in Hydroinformatics. The role of internet and web technologies in Hydroinformatics and gathering data. Sources of data, Telemetry/SCADA and other techniques of data collection.

UNIT II

Process of schematisation/discretisation (in space and time domain). The role of calibration and validation process in modelling. Solution of simple advection equation using FDM, sample code to show how these equations are used. Introduction to basic concepts of hydraulic modelling and governing equations. Use flow simulation models in networks. Hydrologic model-concept and need. Classification of hydrologic models. Physical, empirical, lumped, distributed models with examples, deterministic and probabilistic models. Introduction to popular hydrologic models

UNIT III

Physically-Based Vs Data-Driven Models. Examples of data-driven modelling. Introduction to modern techniques used in hydroinformatics: artificial intelligence, expert systems, neural networks. The use of artificial intelligence (AI) techniques for prediction, simulation, identification, classification and optimisation in the water resources engineering field. Example application of Artificial neural networks and Fuzzy logic techniques to water resources engineering.

UNIT IV

Potential benefits of applying optimisation to water resources problems. Optimisation techniques including evolutionary algorithms (genetic algorithms and genetic programming). Applications of genetic algorithms for water resources.

UNIT V

What is GIS? Fundamentals, Components and Various data structure of GIS, Need of GIS, Applications of GIS. Introduction to ArcView GIS, How to use ArcView GIS to build various themes, query themes, perform spatial analysis & 3D analysis. 3D and 2D data visualisation. What is decision support systems (DSS) and spatial decision support system (SDSS). Components of DSS and SDSS. How to build DSS & SDSS. Demonstration of DSS for water resources problems.

Practical:

Data sources, collection and organization of data
Use of Telemetry/SCADA for data collection
Schematisation/discretisation of data
Application of Artificial neural networks and Fuzzy logic techniques to water resources engineering
Applications of genetic algorithms for water resources
Application of GIS
Building of DSS and SDSS
Demonstration of DSS for water resources problems.

Suggested Books:

- Pratihari, D.K. 2008. Soft Computing. Narosa Publications.
- Praveen Kumar and Marukus. 2005. Hydroinformatics: Data Integrative Approaches in Computation, Analysis, and Modeling. CRC Press, Taylor and Francis Group.
- Robert J. Abraham; Linda M. See; Dimitri P. Solomatine. 2008. Practical Hydroinformatics. Springer Publications
- Kishan Mehrotra, Chilukuri K. Mohan and Sanjay Ranka. 1996. Elements of Artificial Neural Networks. The MIT Press.
- Melanie Mitchell. 1998. An Introduction to Genetic Algorithms. The MIT Press
- Thomas Bäck. 1996. Evolutionary algorithms in theory and practice: evolution strategies, evolutionary programming, genetic algorithms. Oxford University Press.
- Sakawa, Masatoshi. 2001. Genetic Algorithms and Fuzzy Multiobjective Optimization. Operations Research/Computer Science Interfaces Series. Springer Publications.
- Randy L. Haupt. 2004. Practical genetic algorithms. Wiley-IEEE
- Kazuo Tanaka, Tak Niimura. 1996. An Introduction to Fuzzy Logic for Practical Applications. Springer Verlag.
- Masao Mukaidono, Hiroaki Kikuchi. 2001. Fuzzy Logic for Beginners. World Scientific Pub Co Inc.
- Vilem Novak, Jiri Mockor, Irina Perfilieva. 1999. Mathematical Principles of Fuzzy Logic. Kluwer Academic Pub.

IDE 512	Aerodynamics of Evapotranspiration	3(2+1)
Theory:		
UNIT I		
Introduction to Evapotranspiration process: evaporation, transpiration, evapotranspiration; Factors affecting evapotranspiration: weather parameters, crop factor, management and environment conditions;		
UNIT II		
Evapotranspiration concepts: reference crop evapotranspiration, crop evapotranspiration under standard conditions, crop evapotranspiration under non-standard conditions;		
UNIT III		
Evapotranspiration measurement: energy balance and microclimatological balance, soil water balance, lysimeters; Concepts of reference, surface and related terms: aerodynamic resistance, bulk/surface resistance;		
UNIT IV		
Development of different evapotranspiration estimation methods: Need for standard method, formulation of Penman-Monteith equation,		
UNIT V		
Estimation of evapotranspiration and related parameters using FAO Penman-Monteith equation for different time steps, ASCE Penman-Monteith method of		

evapotranspiration estimation, estimating missing climatic data for Penman-Monteith method, alternative methods of evapotranspiration estimation (Hargreaves-Somani, pan evaporation method)

Practical:

Crop evapotranspiration under standard conditions, crop evapotranspiration under non-standard conditions, Measurement of evapotranspiration using energy balance and microclimatological balance, soil water balance, Estimation of evapotranspiration using FAO Penman-Monteith equation for different time steps, Estimation of evapotranspiration using alternative methods (Hargreaves-Somani, pan evaporation method)

Suggested Books:

Richard G. Allen and *et al.* 1990. FAO Irrigation and Drainage Paper No. 56 – Crop Evapotranspiration (guidelines for computing crop water requirements), FAO, Water Resources, Development and Management Service, Rome, Italy

Raghunath H. M. 1997. Hydrology. Wiley Eastern Ltd.

Michael A. M. 1995. Irrigation: Theory and Practice. Vikas Publishing House Pvt. Ltd.

IDE 513

Systems Management in Green House

3(2+1)

Theory:

UNIT I

Introduction – History, origin, development, National and International Scenario, components of green house, perspective, Types of green houses, polysheds /shed nets, Cladding materials,

UNIT II

Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment, Design and construction of green houses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment,

UNIT III

Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.

UNIT IV

Greenhouse heating – necessity, components, methods, design of heating system Root media – types – soil and soil less media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality,

UNIT V

types of irrigation system, components, design, installation and material requirement

Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Maintenance of irrigation and fogging systems

UNIT VI

**Application of Fertilizer – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application
Greenhouse climate measurement, control and management Insect and disease management in greenhouse and net houses Selection of crops for greenhouse cultivation, major crops in greenhouse – irrigation requirement, fertilizer management, cultivation, harvesting and post harvest techniques; Economics analysis**

Practical:

Estimation of material requirement for construction of greenhouse ,Determination of fertilization schedule and rate of application for various crops, Estimation of material requirement for preparation of root media, Root media preparation, bed preparation and disinfections, Study of different planting techniques ,Design and installation of irrigation system ,Design and installation of fogging system ,Greenhouse heating Study of different greenhouse environment control instruments, Study of operation maintenance and fault detection in irrigation system, Study of operation maintenance and fault detection in fogging system, Economic analysis of greenhouses and net houses, Visit to greenhouse

Suggested Books:

- S. Prasad & U. Kumar, Greenhouse management for horticultural crops. Agrobios/ India Publishers & Distributors, Jodhpur
G.N. Tiwari & R.K. Goyal Greenhouse Technology: Fundamentals, Design Modelling & Applications. Narosa Publishing House
P.V. Nelson, Greenhouse operation and management .Prentice Hall, Upper saddle River, New Jersey
L.R. Taft Greenhouse management: Forcing of flowers, vegetables & Fruits. Biotech Books, 1123/74, Sri Nagar, New Delhi

IDE 514

Water Quality and Pollution Control

3(2+1)

Theory:

UNIT I

Impurities in water. Water analysis (Physical, Chemical and Bacteriological).

UNIT II

Indices of water quality for domestic and industrial uses. Monitoring of water quality from various sources of water pollution.

UNIT III

Purification of water supplies.

UNIT IV

Waste water characteristics and disposal methods.

UNIT V

Waste water treatment.

UNIT VI

Mathematical modeling on pollution control. Environmental legislation on water pollution in India and abroad.

Practical:

Determination of pH, dissolved and suspended solids, Chlorides, Sulphates, turbidity, dissolved oxygen hardness, BOD, COD, Nitrogen (Ammonical, nitrate, nitrite), MPN, Total count of bacteria in water/sewage samples.

Suggested Books:

- Garg SK. 2004. Environmental Engineering. Vol. II. Khanna Publ.
- Garg SK. 2004. Environmental Engineering. Vol. I. Khanna Publ.
- Howard S Peavey, Donald R Rod & Tchobanglous G. 1985. Environmental Engineering. McGraw Hill.
- Manual of Water Supply and Treatment. 1999 Ministry of Urban Development, New Delhi.
- Metcalf and Eddy. 2003. Waste Water Engineering Treatment

IDE 592	Special Problem	1 (0+1)
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Special Problem related to any topic in Irrigation and Drainage Engineering. A report on the study to be submitted for evaluation.

IDE 595[#]	Industry / Institute Training	NC
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Minimum of three weeks training at the end of II semester.

B) Minor Subjects

MATH 501

Higher Engineering Mathematics

3(2+1)

Theory:

UNIT I

Review of Calculus - differential and integral ; Vectors ; basic operations, unit vector and direction cosines, vector products and identities;

UNIT II

Differential calculus of functions of several variables; functions, domains and regions, limits and continuity, partial derivative, total differential implicit functions - interse function and Jacobians directional derivatives.

UNIT III

The Laplacians in polar, cylindrical and spherical coordinates; Vector differential calculus; vector and scalar fields, gradients, divergence and curl of a vector; integral calculus of function of several variables; numerical evaluation of definite and indefinite integral; improper integral;

UNIT IV

Two dimensional theory; Limits and integral in plane, line integral as integral of vectors, Green's theorem, independence of path; Fourier Series convergence, generalization, Fourier cosine and sine series, Uniqueness theorem

Practical:

Application of differential calculus, application of cylindrical and spherical coordinates , two dimensional theory , Fourier series, Green's theorem

Suggested Books:

Scarborough, G (2000). Numerical Mathematical Analysis. Oxford & IBH Publishing Co.Pvt.Ltd.

Sokolnikoff, I.S. and Redheffer, R.M.(1966). Mathematics of Physics and Modern Engineering, McGraw-Hill, New York.

Kreyszig, E.(1971). Advanced Engineering Mathematics. Wiley Eastern Private Limited.

Snedden, I.N.(1957). Elements of Pratical Differential Equation. Tata McGraw Hill, New Delhi.

Churchill, R.v.(1960). Complex Variables and Applications. Tata McGraw Hill, New Delhi.

Kaplan, W.(1959) Advanced Calculus Addison-Wesley.

Chatterjee, K.(2000). Integral Calculus and Differential Equations. Tata McGraw Hill, New Delhi.

Coddington, D.(2000). Theory of Ordinary Differential Equations. Tata McGraw Hill, New Delhi.

MATH 502	Methods of Numerical Analysis	2(1+1)
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Theory:

UNIT I

Numerical methods for systems of linear equations, eigen values, interpolation, differentiation.

UNIT II

Least squares. Numerical solution of differential equations and non linear equations in several variables.

Practical:

Practice on matrix manipulation, Exercises on solution of the systems of linear and non linear equations, solution of differential equations

Suggested Books:

- Scarborough, G.(2000). Numerical Mathematical analysis. Oxford & IBH Pub.Co. Pvt.Ltd.
- Chapra, C.(2000). Numerical Methods for Engineers. Tata McGraw-Hill, New Delhi.
- Atkinson, K.(1993). Elementary Numerical Analysis. 2nd Ed John Wiley.
- Epperson, J.F.(2002). An introduction to Numerical Methods and Analysis. John Wiley.

MATH 503	Advance Calculus for Engineers	2(2+0)
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Theory:

UNIT I

Plane analytic geometry, differential and integral calculus and applications,

UNIT II

Transcendental functions, techniques of integration and multiple integrals,

UNIT III

Vector calculus, analytic geometry in space, partial differentiation applications.

Suggested Books:

- Stein, S. and Barcellos, A. (1972). Calculus and Analytical Geometry. McGraw Hill.
- Hilderbrand, F. (1976). Advanced Calculus for Applications. 2nd Ed. Prantice Hall.
- Anton, H. (1995). Calculus and Analytical Geometry. 5th Ed. John Wiley.

STAT 511	Statistical Methods for Applied Science	3(2+1)
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Theory:

UNIT I

Measures of central tendency and dispersion Theory of probability: classical, empirical, axiomatic probability, random variable and mathematical expectation

UNIT II

Discrete and Continuous probability distribution: Binomial, Poisson, Normal, and their application. Concept of sampling distribution: Chi-square, t, and F distribution. Test of

significance based on Normal, Chi-square, t and F distribution. Large sample theory (Z-test).

UNIT III

Correlation and regression: Simple and multiple linear regression model, Stepwise regression, Estimation of parameters, Correlation, Partial and multiple correlation. Rank correlation, Path analysis, Test of significance of correlation coefficients and regression coefficients, coefficient of multiple determination. Polynomial regression model and their fitting, Estimation of parameters.

UNIT IV

Non-parametric tests: sign, Mann-Whitney U test, Run test, Median test.

Practical:

Calculation of mean, median, mode, variance and standard deviation etc. Fitting of Binomial, Poisson and Normal distributions, Large sample test, t, F and Chi-square test, Correlation, Partial and multiple correlation, Rank correlation and linear, multiple and non-linear regression, Path analysis, Non-parametric tests.

Suggested Books:

Snedecor G.W. & W.G. Cochran, (1967) Statistical Methods Sixth Edition, Oxford & IBH Publishing Company, Bombay, W.

Anderson TW 1984. An Introduction to Multivariate Statistical Analysis. 2nd Ed. John Wiley.

Ostle B, (1967) Statistics in Research Oxford & IBH Publishing Company, Bombay,

Robert G. D. Steel and James H. Torrie (1971). Principles and Procedures of Statistics. Biometrical Approach, McGraw Hill International Book Company, New York

Gupta S. C, V.K. Kapoor (1991). Fundamental of mathematical statistics, Sultan

STAT 512

Experimental Design

3(2+1)

Theory:

UNIT I

Need of designing of experiments, characteristics of a good design. Basic principle of designs randomization, replication and local control.

UNIT II

Uniformity trial, size and shape of plots and blocks, analysis of variances, completely randomized design, randomized block design and Latin square design.

UNIT III

Factorial experiments,(Symmetrical and a Symmetrical 23, 32), orthogonality and partitioning of degree of freedom. Concept of confounding in Factorial experiments. Factorial experiments with control treatment, Fitting of quadratic equation and determination of optimum doses.

UNIT IV

Split plot and strip plot design, Analysis of covariance and missing plot techniques in RBD and Latin square design. Transformations, Concept of multi observational data.

Practical:

Analysis of data from CRD, RBD, LSD, Analysis of factorial experiments. Analysis with missing data, Split plot and Strip plot designs, Transformation of data, Analysis of Covariance.

Suggested Books:

- Panse, V.G. and P.V.Sukhatme, 1978. Statistical Methods of Agricultural Workers - IIIrd Edition, - I.C.A.R., New Delhi Publications.
- Cochran, W. G. & Cox, G. M., 1957. Experimental Designs – IInd Edition, John Wiley & Sons, Inc. New York.
- Snedecor G. W. & W. G. Cochran, 1967. Statistical Methods – VIth Edition, Oxford & IBH Publishing Company, Bombay
- Gomez K. A. & A. A. Gomez. 1984. Statistical procedures for Agricultural Research –IInd Edition., John Wiley and Sons, New York
- Nigam, A.K. and V.K.Gupta, 1979. Handbook of Analysis of Agricultural Experiments, 1st Edition, published by Indian Agril. Statistics Research Institute.
- Das, M.N. and N.C. Giri, 1986 Design of Analysis of Experiments- IInd Edition, Published by Wiley Reastern Ltd. New Delhi.
- Oskar Kempthorne, 1952. The Design and Analysis of Experiments 1st Edition, Publisher: John Wiley and Sons, New York

SWCE 504**Watershed Management and Modeling****3(2+1)****Theory:****UNIT I****Problems of desertification and degradation. Models of sediment yield****UNIT II****Survey, monitoring, reclamation and conservation of agricultural and forest lands, hill slopes and ravines****UNIT III****Concept of operational watershed. National land use policy, legal and social aspects****UNIT IV****Watershed management research instrumentation and measurement, problem identification, simulation and synthesis****UNIT V****Modelling of flood and drought phenomenon, drought management and dry farming****Practical:**

Preparation of watershed development proposal, preparation of water shed evaluation report. Application of Models of flood and drought phenomenon. Application of watershed models.

Suggested Books:

- Isobel W Heathcote. 1998. Integrated Watershed Management: Principles and Practice. Wiley Publ.
- Kenneth N Brooks, Peter F Ffolliott, Hans M Gregersen, Leonard F DeBano. 1991. Hydrology and the Management of Watersheds. Wiley-Blackwell

SWCE 507

Land Development and Earth Moving Machinery

2(2+0)

Theory:

UNIT I

Objectives, methods, and equipment for land clearing and development. Machinery selection, mechanics of operation and vegetation types.

UNIT II

Earth moving machinery and earthmoving mechanics. Grading of sloppy lands. Principles of mechanisms used in crawler mounted tractors.

UNIT III

Earth diggers and ditchers. Bull dozers and scrapers. Elevating and self powered graders. Automation of earth moving and grading machines. Lazer guided leveler with global positioning system.

UNIT IV

Boring machines. Different methods of boring.

Suggested Books:

Dutta SK. 1987. Soil Conservation and Land Management. International Distributors, Dehradun.

Eric C Orlem.1997. Earth-Moving Machines. Motorbooks International.

Kuhar JE. 1977. The Precision Farming Guide for Agriculturalist. Lori J. Dhabalt, USA.

Nichols HL & Day DH.1998. Moving the Earth. The Work Book of Excavation. McGraw Hill.

Peurifoy RL. 1956. Construction, Planning, Equipment and Methods.McGraw Hill.

Roger V Amato & Donald J Heimburger 2003. Classic Vintage Crawlers and Dozers. B Heimburger House Publ.

Singh G.1991. Manual of Soil and Water Conservation Engineering. Oxford & IBH.

SWCE 509

Fluvial Hydraulics

3(2+1)

Theory:

UNIT I

Sediment properties, Sediment problems. Incipient motion of sediment particles.

UNIT II

Regimes of flow. Resistance to flow.

UNIT III

Sediment deposition process. Estimation of sediment load. Bed load. Suspended load. Total load transport.

UNIT IV

Alluvial streams and their hydraulic geometry. Bed level variations in alluvial streams.

UNIT V

Sediment samples and sampling. Alluvial river models. Sediment transport through pipes. Bed level variations in alluvial streams. River models.

Practical:

Problems on determination of sediment properties, regimes of flow, resistance to flow, incipient motion, bed load, suspended load, total load transport and sediment transport.

Suggested Books:

- Garde RJ & Ranga Rajan KG. 2001. Mechanics of Sediment Transport and Alluvial Stream Problems.
 Howard H Chang. 1988. Fluvial Process in River Engineering. John Wiley & Sons.
 Raudkivi AJ. 1990. Loose Boundary Hydraulics. Pergamon Press.

SWCE 510	Statistical Hydrology	3(3+0)
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Theory:**UNIT I**

Probability concepts. Discrete and continuous frequency distributions; Hyper geometric distribution, Bernoulli and Poisson process, Normal distribution, Other Continuous probability distributions- Uniform, Exponential, Gamma, Log-Normal, Extreme value, beta, Pearson.

UNIT II

Graphical and mathematical construction of probability paper, probability plotting.

UNIT III

Fitting empirical Distributions to precipitation and other hydrologic variables. Analytical frequency analysis, Regional frequency analysis.

UNIT IV

Linear, Multiple linear regression and application. Hypothesis testing, chi-square, t, F, K-S test.

Suggested Books:

- Haan, C.T. 1977. *Statistical Methods in Hydrology*. Iowa State Uni. Press, Ames.
 Mutreja, K.N. (1986) *Applied Hydrology*. Tata McGraw Hill Book Co., New Delhi.
 Chow, V.T. (Ed) (1964) *Handbook of Applied Hydrology*. McGraw Hill Book Co., New York.

SWCE 511	Dams and Reservoir Operations	3(2+1)
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Theory:**UNIT I**

Dams classification. Suitable site selection for dams & reservoirs. Survey & planning of storage projects.

UNIT II

Type of concrete dams. Forces acting on concrete dams. Stability analysis. Methods of design of gravity dams. Temperature control for dams.

UNIT III

Fitting empirical Distributions to precipitation and other hydrologic variables. Analytical frequency analysis, Regional frequency analysis.

UNIT IV

Earth dams and their types. Methods of construction. Causes of failure & remedial measures. Seepage and stability analysis of earth dams.

UNIT V**Foundation treatment. Abutment grouting. Instrumentation in dams.****UNIT VI****Spill way and spillway capacities and spillway gates.****UNIT VII****Reservoir planning, Storage, sedimentation, Losses, Economics. Flood routing.**

Practical:

Exercises on above topics.

Suggested Books:

Bharat Singh. 2002. Earthen Dams. New Chand & Bros., Roorkee.

Creager WP, Justin JD, Hinds J. 1945. Engineering for Dams. Vols. I-III. John Wiley & Sons.

Sharma HD. 1981. Concrete Dams. Metropolitan.

C) Supporting Subjects**AE 502****Similitude in Engineering****3(2+1)****Theory:**

UNIT I**Dimensions and units.****UNIT II****Dimensional and similarity analysis. Theory of models.****UNIT III****True, distorted and dissimilar models.****UNIT IV****Application to different systems with special reference to Structural and fluid flow systems, Analogues.**

Practical:

Equations for the period of simple pendulum. Uniform rectangular cantilever beam. Spring mass level system. Investigation of extrapolation. Deflection of a cantilever beam. Prediction of the deflection of a beam using a model. Analogue model experiments

Suggested Books:

Green Murphy.1950. Similitude in Engineering. Ronald Press.

Huntley HE. 1974. Dimensional Analysis. Dover Publ.

Stephen J Klin.1965. Similitude and Approximation Theory. McGraw Hill.

BSCT 501

Computer Graphics

3(2+1)

Theory:

UNIT I

Graphic display devices, Interactive devices, Line and circle plotting techniques by using Bresenham's algorithm, Windowing and clipping, Sutherland Copen algorithm, Cyrus and Beck method.

UNIT II

Curve drawing using Hermite Polynomial, Bezier curve, B Splines, Picture Transformation, translation, rotation, Scaling and Mirroring

UNIT III

3D Graphics, 3D transformation rotation about an arbitrary axis. Curved surface generation, Hidden surface removal.

UNIT IV

Orthogonal Projection and multiple views, Isometric projection, Perspective projection, 3D Clipping

UNIT V

Generation of solids, Sweep method, Interpolation, Graphic Standards, CGS Modeling, Applications of Computer Graphics.

Practical:

Practical problems on above topics.

Suggested Books:

Hearn Donald.1996. Computer Graphics. PHI.

Schaum. Series. 2004. Computer Graphics. TMH.

MATH 504

Neural Network and Its Applications

3(2+1)

Theory:

UNIT I

Introduction to neural network and its comparison with biological system. Perceptron and linear separable functions, multi-layers perceptrons.

UNIT II

Back propagation, one basic learning algorithm for feed-forward neural network, variation and improvement for back-propagation algorithm, Generalisation of learning algorithm.

UNIT III

Recurrent Networks: Hopfield networks and Boltzmann Machine.

UNIT IV

Unsupervised learning and self organized features maps.

UNIT V

Application of neural network in function approximation, time series predictions, pattern recognition, control systems and optimization in engineering problems.

Practical:

Development of neural network by back-propagation learning algorithm using MATLAB for function approximation, time series predictions, pattern recognition, control systems and optimization in engineering problems

Suggested Books:

- Haykins S.1999. Neural Network- Comprehensive Study. PHI.
 Hertz J, Krogh A & Palmer RG. 1991. Introduction to Theory of Neural Computation. Addison-Wesley.

FMPE 521	Computer Aided System Design	2(0+2)
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Practical:

Introduction to computer aided design, Geometric modeling and interactive graphics, Computer aided analysis and synthesis of common mechanical components. Application of numerical methods and optimal techniques to machine design problems. Computer aided selection of standard mechanical components. Introduction to FEM.

Preparation of engineering drawings of machine / implement components, design of plough share / furrow openers / plough discs, and other components of farm machinery, preparation of bill of material and costing.

Suggested Books:

- Rammurthy, T. 2001. *Computer Aided Mechanical Design and Analysis*. Tata McGraw Hill, New Delhi.
 Mukhopadhyay, M. 2000. *Matrix, Finite Element, Computer and Structural analysis*, Oxford & IBH Publishing Co. Pvt Ltd.
 Krishnamoorthy, G. 2001. *Finite Element Analysis. Theory and Programming*. Tata McGraw Hill, New Delhi.
 Knudra, C.V. 2000. *Numerical Control and Computer Aided Manufacturing*. Tata McGraw Hill, New Delhi.
 Zeid, K. 2000. *CAD/CAM Theory and Practice*. Tata McGraw Hill, New Delhi.

AE 503	Applied Instrumentation	3(2+1)
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Theory:**UNIT I**

Basic instrumentation systems and transducer principles. Displacement Transducers: Potentiometer, LVDT, Piezoelectric and capacitive transducers. Digital Transducers. Velocity transducers – Analog and Digital

UNIT II

Acceleration and absolute motion measurement. Force transducer Strain Gauge, Hydraulic load cell, Cantilever type and Probing ring. Method of separation of force – Torque, Power and Energy measuring techniques.

UNIT III

Temperature measurement using Bi-metals, PTRs, Thermistors, Thermocouples, Electronic IC sensors and Pyrometers. Heat flux measurement. Humidity measurement – Dry and Wet bulb, Hair hygrometer and Humister. Soil and Grain moisture transducers, pressure measurement – Manometers, Bourdon Tube, Diaphragm type transducer. High pressure and vacuum sensing techniques.

UNIT IV

Flow transducers, Positive displacement, venturimeter, Rotameter, Drag force, Ultrasonic, Electromagnetic, Hot wire anemometers. Time and frequency measurement.

UNIT V

Level measurement, OD and pH measurement, PCO2 and grain quality measurement. Biomedical measurement – BP, ECG etc., Ultrasonic flaw detection, Spectroscopy.

Practical:

Study the characteristics of various transducers : Potentiometer, LVDT, Proximity sensors and Photo pickups, Load cell, Thermistor and Thermocouple, LM 335/AD 590se of various Analog interfacing blocks: Attenuators, Amplifiers, A/D converters, Filters, digital interfaces using Wave shapers and level shifters. Practice of using interfaces and developing suitable software for data acquisition through PC/Microcomputer: Use of Microcomputer kit, Study the use of 8255 I/O IC, Study the use of printer port in a PC. Data acquisition through PC/Kit.

Suggested Books:

Doebelin EO.1990. Measurement Systems Applications and Design. Tata McGraw Hill.
 Nakra BC &Chaudhary KK. 2004. Instrumentation Measurement and Analysis. Tata McGraw Hill.
 Sawhney AK. 2008. Electrical and Electronics Measurement and Instrumentation. Dhanpat Rai & Sons.

BSCT 502	Computer Languages for Engineering Applications	3(1+2)
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Theory:**UNIT I**

Introduction to Computer Systems, Hardware and Software. Types of programming languages. System Development life cycle.

UNIT II

Programming Language: Procedural Approach- C++, History of C++, Introduction to various C++ compilers and its working.

UNIT III

C++ Programming: Structure of C++ program, input and output statement, Declaration statements and variables, assignment statement.

UNIT IV

Data types, arithmetic and relational operator. Arrays, Strings and structure data types. Looping and Branching Statements and logical operators. Functions: Defining the function, function prototyping and function calls, Passing and returning arguments.

UNIT V

Multidimensional Arrays. Pointers. Introduction to Objects and Classes. Implementation of Data Structures: Linked List, Stacks and Queues, Binary Trees and Graphs, Sorting and Searching

Practical:

Study of Structure of C++ program, input and output statement, Declaration statements and variables, assignment statement, Study of Data types, arithmetic and relational operator, Study of arrays, strings and structures. Study of functions, Study of pointers and data structures

Suggested Books:

C++ Primer plus, Stephen Prata, Galgotia publications
 Object Oriented Programming with C++, E. Balguruswamy, Tata McGraw Hill Publications Ltd New Delhi.
 Tan A. 1999. *C programming for engineers and computer science*. McGraw-Hill, New York.
 Data Structures and Algorithms in C++, Adam Drozdek, Thomson Brooks.Cole, Vikas Publishin House

D) Seminar

IDE 591

Seminar

1(0+1)

Student will have to deliver seminar(s) on the topics related to Irrigation and Drainage Engineering.

E) Masters' Research

IDE 599

Master's Research

20 (0+20)

F) Non Credit Compulsory Courses

PGS-501

Library and Information Services

1(0+1)

Practical:

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS-502

Technical Writing and Communicating Skills

1(0+1)

Practical:

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Books:

- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary. 1995. Harper Collins.
- Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
- James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Mohan K. 2005. Speaking English Effectively. MacMillan India.
- Richard WS. 1969. Technical Writing. Barnes & Noble.
- Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
- Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PGS-503 Intellectual Property and Its Management in Agriculture 1(1+0)

(e- Course)

Theory:

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Books:

- Erbisch FH & Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 20

PGS-504 Basic Concepts in Laboratory Techniques 1(0+1)

Practical:

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vascupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Books

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions.
Chemical Publ. Co.

PGS-505 Agricultural Research, Research Ethics and Rural 1(1+0)
Development Programmes

(e-Course)

Theory:

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Books:

- Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
- Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
- Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
- Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

PGS-506**Disaster Management****1(1+0)****(e-Course)****Theory:**

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Books:

- Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
- Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.