ORGANIZATION OF COURSE CONTENTS & CREDIT REQUIREMENTS

Code Numbers

- All courses are divided into two series: 500-series courses pertain to Master's level, and 600-series to Doctoral level. A Ph. D. student must take a minimum of two 600-series courses, but may also take 500-series courses, if not studied during Master's programme.
- Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691 and 692, respectively.
- Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Course Contents

The contents of each course have been organized into:

- Objective – to elucidate the basic purpose.
- Theory units – to facilitate uniform coverage of syllabus for paper setting.
- Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
- A list of journals pertaining to the discipline is provided at the end which may be useful as study material for 600-series courses as well as research topics.
- E-Resources - for quick update on specific topics/events pertaining to the subject.
- Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Minimum Credit Requirements

Subject	Master's programme	Doctoral programme
Major	20	15
Minor	09	08
Supporting	05	05
Seminar	01	02
Research	20	45
Total Credits	**55**	**75**
Compulsory Non Credit Courses	See relevant section	

Major subject: The subject (department) in which the students takes admission

Minor subject: The subject closely related to student's major subject (e.g., if the major subject is Entomology, the appropriate minor subjects should be Plant Pathology & Nematology).

Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.

Non-Credit Compulsory Courses: Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph.D. students may be exempted from these courses, if already studied during Master's degree.

IRRIGATION AND DRAINAGE ENGINEERING

Course structure at a glance

CODE	COURSE TITLE	CREDITS
IDE 501*	Irrigation Planning and Management	2+1=3
IDE 502*	Design of Surface Irrigation Systems	2+1=3
IDE 503*	Reclamation of Irrigated Lands	2+1=3
IDE 504*	Agricultural Drainage System	2+1=3
IDE 505	Open Channel Flow	3+0=3
IDE 506	GIS and Remote Sensing for Resources Management	2+1=3
IDE 507	Water Resources System Engineering	3+0=3
IDE 508	Irrigation Economics Planning and Management	2+1=3
IDE 509	Water Conveyance and Distribution	2+1=3
IDE 510	Design of Sprinkler and Micro Irrigation System	2+1=3
IDE 511	Crop Environmental Engineering	2+0=2
IDE 512	Design of Pumps for Irrigation and Drainage	2+1=3
IDE 513	Ground Water Engineering	2+1=3
IDE 514	Soil-Water-Plant Relationship	2+1=3
IDE 515	Water Supply and Treatment	3+0=3
IDE 516	Climate Change and Water Resources	3+0=3
IDE 591	MASTER'S SEMINAR	1+0=1
IDE 592	SPECIAL PROBLEM	0+1=1
IDE 595#	INDUSTRY/ INSTITUTE TRAINING	NC
IDE 599	MASTER'S RESEARCH	20
IDE 601**	Design, Operation & Evaluation of Pressurized Irrigation System	2+1=3
IDE 602**	Advances in Irrigation and Drainage	3+0=3
IDE 603	Hydro-Chemical Modelling and Pollutant Management	3+0=3
IDE 604	Plant Growth Modelling and Simulation	2+1=3
IDE 605	Flow through Porous Media	2+0=2
IDE 606	Advanced Hydo-Mechanics in Soil Aquifer Systems	3+0=3
IDE 607	Command Area Development	2+1=3
IDE 691	DOCTORAL SEMINAR I	1+0
IDE 692	DOCTORAL SEMINAR II	1+0
IDE 693	SPECIAL PROBLEM	0+1
IDE 694	CASE STUDY	0+1
IDE 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme; ** Compulsory for Doctoral programme
# SWE 595 – Minimum of Three Weeks Training

Note: Some of the identified Minor/Supporting fields are Soil and Water Conservation Engineering, Mechanical Engineering, Processing & Food Engineering, Farm Machinery and Power Engineering, Renewable Energy Engineering, Civil Engineering, Computer Science, Electrical Engineering, Mathematics and Statistics; the contents of some of the identified Minor/Supporting courses have been given.

IRRIGATION AND DRAINAGE ENGINEERING

Course content

IDE 501 IRRIGATION PLANNING AND MANAGEMENT 2+1

Objective

Understanding of irrigation technologies and systems, able to develop irrigation schedule and canal water distribution and operation, assessment and appraisal for water availability in command area, able to evaluate performance of irrigation projects based on water delivery.

Theory

UNIT I

Basic terminology used in planning of irrigation projects, duty of water, its determination and factors affecting it. Methods of improving duty of canal water.

UNIT II

Canal scheduling, assessment and appraisal of water availability in command areas, preliminary planning and investigation in irrigation project formulation.

UNIT III

Socio economic aspects of irrigation management, Water management problems in command areas and their possible remedies.

UNIT IV

Multi objective command area planning for the better management of irrigation water, conjunctive use of canal and groundwater.

UNIT V

Root zone water balance, water allocation, real time irrigation scheduling, performance appraisal of irrigation projects- equity, adequacy. Design of on farm water distribution network.

Practical

Review of main features of some major irrigation projects, review of literature regarding evapotranspiration, problems on determination of evapotranspiration by climatological methods, problems on irrigation scheduling, problems on determination of duty, review on canal operation methods, development of crop coefficient curves.

Suggested Readings

Doorenbos, J. and W. O. Pruitt. (1977). Guidelines for Predicting Crop Water requirement, Irrigation and Drainage Paper No. 24, FAO, UN, Rome.

Michael, A. M. (2006) Irrigation-Theory and Practices, Vikas Publishing House Pvt. Ltd., New Delhi. 799 pp.

Annonymous, (1982), Organization, Operation and Maintenance of Irrigation Schemes, Irrigation and Drainage Paper No. 40, FAO, UN, Rome. 189 pp.

T. B. S. Rajput and A. M. Michal, (1990). Scheduling of canal deliveries. Application of the Integrated Canal Scheduling Model, Irrigation and Power Journal 47(1): 17-39.

L. Kalu, G. N. Paudyal and A. Dasgupta, (1995). Equity and Efficiency issues in Irrigation Water Distribution. Journal of Agric. Water Management, 28(4): 335-348.

IDE 502 DESIGN OF SURFACE IRRIGATION SYSTEMS 2+1

Objective

Selection of suitable method of surface irrigation based on land irritability and infiltration characteristics, design and evaluation of various surface irrigation

methods, design optimum layout, conveyance network for efficient use water in surface irrigation system.

Theory

UNIT I

Historical evidence of development and progress of farm irrigation systems

UNIT II

Land irrigability, Theory of Infiltration and its measurement, Methods of irrigation-their selection and suitability

UNIT III

Surface Irrigation Systems- Water advance, wetting, depletion and recession in surface irrigation

UNIT IV

Field data and performance measures of surface irrigation systems, evaluation and design of surface irrigation methods- border, basin and furrow method, surge irrigation and adaptability and design.

UNIT V

Irrigation scheduling and equity in water distribution, optional layout of conveyance network-shortest route and minimum tree spanning tree approach.

Practical

Infiltration test and mathematical representation of the test result, estimation of required irrigation depth based on soil moisture analysis, calculation of irrigation efficiencies, design and evaluation of irrigation methods, developing irrigation plan for a project, measurement of seepage loss, preparation of irrigation water distribution rosters for beneficiaries under different methods of water distribution.

Suggested Readings

Michael, A.M. (2006). Irrigation Theory and Practice. Vikas Publ. New Delhi.

Jensen, M.E. (Editor). (1983). Design and Operation of Farm Irrigation Systems, ASAE, Monograph No. 3. USA.

Walker, W.R. and G.V. Skogerboe. (1987). Surface Irrigation: Theory and Practice Prentice-Hall Inc. New Jersey, USA

James. L.G. (1988). Principles of Farm Irrigation System Design. John Wiley and Sons, New York, USA.

Withers, Bruce and Vipond, Stanley. (1974). Irrigation: Design and Practice. B.T. Batsford Ltd., London.

IDE 503 RECLAMATION OF IRRIGATED LANDS 2+1

Objective

Able to identify the various types of problematic soils, develop competency for reclamation of problematic and water logged soils, understanding of leaching requirement, Hydraulic conductivity and design of drainage system.

Theory

UNIT I

Causes of waterlogging and soil salinity in irrigated lands, Extent of waterlogging and soil salinity in arid and semi-arid lands, , ,

UNIT II

Field investigations of soil and water salinity components, Movement of water and salts

UNIT III

Control for seepage and leakage from canal network, Groundwater geology considerations, Quality of canal and ground water, Water balance, Salt balance,

UNIT IV

Use of amendments for reclamation or irrigated lands, leaching of salts

UNIT V

Disposal of drainage water, Reuse of drainage water. Sensor based drainage system.

Practical

Diagnosis of salinity and waterlogged area in a minor, soil investigation of a watershed area pH, EC, SAR, etc. hydraulic conductivity, soil investigation of a saline area pH, EC, SAR, etc. hydraulic conductivity, determination of quality of canal and groundwater, calculation of amendments for reclamation of a saline area, estimation of leaching requirement, design of drainage system in a salt affected area

Suggested Readings

Ritzema, H.P. (Ed) (1994). Drainage Principles and Applications, Second Edition, International Institute for land Reclamation and Improvement; Wageningen. The Netherlands.

Singh, R.V. (Ed) (1991), Drainage and Salinity Control, Himanshu Publication, Udaipur.

Rao KVGK, Agrawal MC & Singh OP (1993), Reclamation and Management of Waterlogged Saline soils. CSSRI Karnal.

IDE 504 AGRICULTURAL DRAINAGE SYSTEMS 2+1

Objective

To acquaint and equip with the importance and phenomenon of drainage system along with design consideration of surface and sub-surface drainage systems

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-de-leur 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 water- logged 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 sub- surface drainage systems, design of filter and envelop materials.

Suggested Readings

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

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

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 505 OPEN CHANNEL FLOW 3+0

Objective

To acquaint and equip with the hydraulics of surface water flow phenomenon in open channels

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 Readings

Chaudhry MH. 1993. Open Channel Flow. Prentice Hall.

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

Henederson FM. 1966. Open Channel Flow. MacMillan.

IDE 506 GIS AND REMOTE SENSING FOR LAND AND WATER RESOURCE MANAGEMENT 2+1

Objective

To acquaint and equip with the techniques of Remote Sensing and application of GIS for land and water resources management.

Theory

UNIT I

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

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 Readings

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 507 WATER RESOURCES SYSTEM ENGINEERING 3+0

Objective

Able to identify objective function and components in water resource planning problems, able to formulate and solve various mathematical programming models of water resource system, able to develop conjunctive use and crop production function optimization models.

Theory

UNIT I

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

UNIT II

Mathematical programming technique , 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 Readings

Larry WM. (1996) Water Resources Handbook. Mc-Graw-Hill.

Loucks DP et al. (1981). Water Resources System Planning and Analysis Prentice Hall.

Rao SS. (1978) Optimization Theory and Application. Wiley Eastern.

Wallander WW, BOS M (1990) Water resource system Planning & Management.

IDE 508 IRRIGATION ECONOMICS PLANNING AND MANAGEMENT 2+1

Objective

Able to estimate the cost benefit analysis, pricing and investment criteria on irrigation project evaluation and finding their problems, to impart the knowledge of various public and government policy on regulation and allocation of irrigation water.

Theory

UNIT I

Criteria for investment in irrigation projects. Economics analysis of irrigation projects, cost benefit analysis, pricing and investment criteria on irrigation project evaluation, social benefits, problems and causes of under-utilization.

UNIT II

Impact of public policies on regulation and allocation of irrigation water. Relative economic efficiency of alternative irrigation water management models irrigation system improvement by simulation and optimization.

UNIT III

Economic and social benefits of irrigation projects after institutional and legal aspects in the use of irrigation water. Technological changes and irrigation water use efficiency.Methods and approaches to water pricing.

UNIT IV

Indian agriculture, main problems, population, government policies, systems, organizing agriculture production, socio-economic survey, importance of such survey in planning, implementation and evaluation of project performance.

UNIT V

Farm Management- definition, Importance, scope, relation with other sciences and its characteristics. Role of farm management principles in decision making for irrigated agriculture.

UNIT VI

Socio–economic survey:- Data set and data point. Statistics main division and nature of statistics, planning of socio-economic survey.

UNIT VII

Collection of data:- Primary and secondary data, questionnaires & schedules sampling, editing and scurting of secondary data, classification and tabulation and analysis of data

Practical

Exercise on cost benefit analysis, Working out net present value anb BC ratio of irrigation project nearby Udaipur, Exercise on par back period and internal rate of returns, Exercise on interpretation of social benefits, Field exercise on socio-economic survey schedule and interlink the respondents and collection of data, Exercise on analysis of data and interpretation, Field exercise on economic of irrigation crops and farms.

Suggested Readings

James, Douglas and Lee. Rober R-Economics of Water Resource Planning. Tata Mcgraw-Hill Publication Company Ltd., Bombay, New Delhi.

Sharma, V.K. (1985) Water Resource Planning and management. Himalaya Publication House, New Delhi.

Management of Water Project-Decision making and investment appraisal. Oxford Publication Co.

Heady, Early O.R. Hexem, Rogrew Water Production Functions for irrigated Agriculture.

Agarwal, A. N. Indian Economic Problems of Development and Planning.

Joshi, S.S. and T.R. Kapoor, (2001), Fundamentals of Farm Business management. Kalyani Publishers, Ludhiyana.

IDE 509 WATER CONVEYANCE AND DISTRIBUTION 2+1

Objective

To develop the common understanding of different conveyance structure in canal irrigation network, able to infuse the knowledge about different types of channel flow and their behavior, able to gain the knowledge of appraisal of flow control and distribution structures.

Theory

UNIT I

Channel characteristics, Prismatic and non-prismatic channel, Steady, unsteady, uniform and non-uniform flow

UNIT II

Dimension-less representative parameters of flow behavior, Energy and momentum in open channel flow.

UNIT III

Critical uniform, gradually varied rapidly varied and spatially varied flows and their computations

UNIT IV

Energy dissipation, Flow control structures, Flow measurement, Theories and methods of open channel design

UNIT V

Water conveyance through pipes – Design & evaluation. Methods of Seepage estimation and control measures – Lining Material

Practical

Computation and use of geometrical and hydraulic elements of open channel, Use of flow measuring devices and methods and their limitations, Examination of velocity distribution and calculation of energy and momentum coefficients, Solution of channel design problems, Appraisal of flow control and distribution structures, Analysis and computation of flow profiles.

Suggested Readings

Chaudhry M.H. (1993). Open channel Flow. Prentice-Hall, NJ.

Chow, Ven T. 1959. Open Channel Hydraulic, Mc-Graw Hill Book Co. New York.

Kinori, B.Z. (1970). Manual of Surface Drainage Engineering. Elsevier Publ. Co. Amsterdam.

Henderson, F.M. (1966). Open Channel Flow. Macmillan Co. New York.

USBR. (1977). Water Measurement Manual. United States Bureau of Reclamation.

IDE 510 DESIGN OF SPRINKLER AND MICRO IRRIGATION SYSTEM 2+1

Objective

Able to hydraulic design of drip as well as sprinkler irrigation system for particular area and crop based on water requirement, able to calculate uniform distribution of water and pressure distribution through entire system, able to compute the size of pipe for conveying the flow of water in drip as well as sprinkler irrigation system.

Theory

UNIT I

Suitability of sprinkler and micro irrigation systems under Indian conditions. Basic hydraulics of sprinkler and micro irrigation system

UNIT II

Pipe flow analysis. Friction losses and pressure variation. Flow in nozzles and emitters

UNIT III

Design & evaluation of sprinkler and micro irrigation systems in relation to source, soil , climate and topographical conditions.

UNIT IV

Selection of pipe size, pumps and power units, layout distribution, efficiency and economics

UNIT V

Fertigation/ chemigation through sprinkler and micro irrigation systems.

Practical
Based on theory and recent advances in the field.

Suggested Readings
Michael, A.M. 2006. Irrigation Theory and Practice. Vikas Publ. New Delhi.
Jensen, M.E. (Editor). (1983). Design and Operation of Farm Irrigation Systems, ASAE, Monograph No. 3. USA
James. L.G. (1988). Principles of Farm Irrigation System Design. John Wiley and Sons, New York, USA.
Withers, Bruce and Vipond, Stanley. (1974). Irrigation : Design and Practice. B.T. Batsford Ltd., London.
Sivanappan, R.K. (1987). Sprinkler Irrigation. Oxford and IBH Publishing Co. New Delhi.
Sivanappn, R.K. Padmakumari,O. and Kumar V.(1987). Drip Irrigation. Keeerthy Publishing House Coimbature.
Keller, J. and Karmeli, D. (1975). Trickle Irrigation Design. Rainbird Sprinkler Manufacturing Corporation. Glendora, California, USA
Karmeli, D., Peri, G. and Todes, M. (1985). Irrigation Systems: Design and Operation. Oxford University Press. Captown.

IDE 511 CROP ENVIRONMENTAL ENGINEERING 2+0

Objective
To develop the common understanding aerial and edaphic environments for plant growth, energy and mass transfer which help to maximizing the crop yield, to understanding the basic interface of soil and root and its characteristics, able to identify climatic changes on plant and how plan are response to environmental stresses, evapotranspiration.

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
Water movement in soil-plant atmosphere continuum, artificial environments and plant behavior. Water requirement of crops in controlled environment.
UNIT V
Design and operation of controlled environment facilities and their instrumentation. Crop growth and yield modelling. Remote sensing based modelling.

Suggested Readings
Ghildyal BP and Tripathy RP. 1987. Fundamental of Soil Physics. Wiley Eastern.
Slatyor OP. 1967. Plant Water relationship. Academic Press.
Gomtia N.K. & Tiwari K.N. 2008. Irrigation Scheduling & Crop water Stress using Remote sensing & GIS, Lamber Publication

IDE 512 DESIGN OF PUMPS FOR IRRIGATION AND DRAINAGE 2+1

Objective

Able to select the pump for desired discharge to be pumped from particular water source by developing pump characteristics curve, able to analyze the flow in different types of pump, able to design the pumping station for managing the irrigation and drainage system.

Theory

UNIT I

Design principles of the common types of pumps and well lifts, Influence of design parameters on the pump performance

UNIT II

Matching of pumps with prime movers, Matching of pumps and prime movers with water source

UNIT III

Non-conventional energy sources for pumping, Assessment of wind energy and design of wind mill, Assessment of solar insolation and selection of photovoltaic pump

UNIT IV

Hydraulic ram and its design, Energy loss in pressurized conveyance of pumped water

UNIT V

Design of pumping plant for irrigation and drainage.

Practical

Performance evaluation of pumps and prime movers, Selection of suitable pump and prime mover with appropriate technical specifications to satisfy irrigation and drainage requirement of a given area, Estimating irrigation command for wind mill and solar photovoltaic pump for a known water sources,

Suggested Readings

Church, A. H. and Jagdish Lal. (1973). Centrifugal Pumps and Blowers, Metropolitan Book Co. Pvt. Ltd. Delhi.

Bansal, R. K. (1990). A Text Book of Fluid Mechanics and Hydraulic Machines. Laxmi Publications, New Delhi.

Luthine, J N. (1966). Drainage Engineering, Wiley and Sons. New York, USA.

Michael, A. M. and Khepar, S. D. (1989). Water Wells and Pump Engineering. Tata McGraw Hill Publishing Co., New Delhi.

IDE 513 GROUND WATER ENGINEERING 2+1

Objective

After completion of course student will be able to analyze storage, movement and flow characteristics of different aquifers, able to model ground water and plan for ground water recharge.

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 modelling 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 Readings
Boonstra J & de Ridder NA.1981. Numerical Modelling of Groundwater Basins. ILRI.
Demenico PA 1972. Concept and Models in Groundwater Hydrology. Mc Graw Hill.
Jat, M.L. and SR Bhakar 2008. Ground Water Hydrology. Agrotech Publishing Academy, Udaipur.
Huisman L.1972. Ground Water Recovery, Mac Millan.
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 514 SOIL-WATER-PLANT RELATIONSHIP 2+1

Objective
After completion of course student will be able to analyze factors responsible for water movement in soil, plant and evaporative demand of plant, student will be able to estimate the evapotranspiration using meteorological data.

Theory
UNIT I
Aerial and edaphic environment for plant growth, Energy and Mass transfer in and above crop canopies, Plant response to environmental stresses, Evapo-transpiration models, Instrumentation techniques for monitoring plant environment, Processes and aspects of growth and development, Soil root interface, Root sink functions,
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
Water movement in soil-plant-atmosphere continuum, Artificial environment and plant behavior

UNIT V

Design and operation of controlled environment facilities and their instrumentation.

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 Readings

Boonstra J & de Ridder NA.1981. Numerical Modelling of Groundwater Basins. ILRI.

Demenico PA 1972. Concept and Models in Groundwater Hydrology. Mc Graw Hill.

Jat, M.L. and SR Bhakar 2008. Ground Water Hydrology. Agrotech Publishing Academy, Udaipur.

Huisman L.1972. Ground Water Recovery, Mac Millan.

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 515 Water Supply and Treatment 3+0

Objective

Understanding importance and necessity of water Supply scheme, water quality, water treatment objectives and water conveyance system and able to estimate water demand for population of target area.

Theory

UNIT I

Water Quantity: Importance and necessity of water supply scheme. Water demands and its variations. Estimation of total quantity of water requirement. Population forecasting. Quality and quantity of surface and ground water sources. Selection of a source of water supply. Types of intakes.

UNIT II

Water Quality: Impurities in water and their sanitary significance. Physical, chemical and bacteriological analysis of water, water borne diseases, water quality standards.

UNIT III

Water Treatment: Objectives, treatment processes and their sequence in conventional treatment plant, sedimentation – plain and aided with coagulation. Types, features and design aspects. Mixing basins and Flocculation units. Filtration – mechanism involved, types of filters, slow and rapid sand filtration units (features and design aspects), Disinfection principles and aeration. Other water treatment processes: Purification processes in natural systems, water softening, removal of taste and odour, advanced methods of water treatment, deflouridation, dissolved solids removal.

UNIT IV

Water Conveyance System: Conveyance of water, Intake structures, Rising and Gravity system, Dual systems, Pumping Systems and pumping stations, valves and appurtenances, pipe materials and pipe fitting, O&M and trouble shooting for conveyance system.

UNIT V

Water Distribution System: Layout of Distribution system – Dead End system, Grid Iron system, Ring system, Radial system, their merits and demerits,

Distribution Reservoir- functions and determination of storage capacity, Water Distribution Network, analysis of distribution network, layout, capacity and pressure requirements, leak detection, Maintenance, Water supply in buildings and plumbing.

Suggested Readings

Steel, E.W. Water Supply and Sewerage
Terence, J. Mc Ghee Water Supply and Sewage by J. Mc Ghee.
Kshirsagar, S.R. Water Supply Engineering
Garg, S. K. Water Supply Engineering
Punmia, B.C., Jain, Ashok & Jain, Arun. Water Supply Engineering: B.C. Punmia, Ashok Jain & Arun Jain.
Manual on Water Supply and Treatment: Ministry of Urban Dev., New Delhi.
Chatterjee, A. K. Water Supply Waste Disposal and Environmental Pollution Engineering.
Duggal, K. N. Elements of Public Health Engineering.
Birdie, G. S. and Birdie J. S. Water Supply and Sanitary Engineering
Peavy, S., Donald, R. Rowe and George Tchobanologlous Environmental Engineering
Mark, T. Hammer, Water and Waste Water Technology

IDE 516 Climate Change and Water Resources 3+0

Objective

To acquaint and equip the students with the concepts of weather and climate, to make them familiars with climate changes and there impacts on different resources on the earth. How to tackle the problem the climate change. Forecasting methods for prediction of water resources for effective under future under climate change.

Theory

UNIT I

Climate and weather: Basic concept of climate, Climate and weather, climatic classification, drivers of climate change, over view of changing climate, analysis of climate change, climate forecasting.

UNIT II

Hydrologic system overview with drought and floods: Hydrologic system overview, global and national water budget, rainfall and temperature variability, an overview of climate change effects on water (runoff, ET, Soil Moisture, GW), and soil (sediment) resources, climate change and droughts & floods.

UNIT III

Climate forecast: GCM and RCM. An overview of future climate scenarios, Assessment of future water resources (surface/GW/SM) status and vulnerability. Application of hydrologic models in present and future resources assessment, probabilistic methods of results interpretation of future water resources.

UNIT IV

Adaptation and mitigation under climate change: Climate change adaptation capacity & methods analysis, Sensitivity of the changing climate on WR, Application of CC forecasts on water resources management (reservoirs, surface water, GW).

UNIT V

Impact on climate change on water resources and agriculture: Impact on climate change case studies, agriculture, waters resources in India and around the globe. Case studies based on different river basin of India and globe. Application of hydrological modelling to assess the impact the climate change in future.

Suggested Readings

Cowie Johathan (2013). Climate change Biological and Human Aspects, Cambridge University Press.
Lal, D. S (2012). Climatology, Sharda Pustak Bhawan.
Singh, B. K (2012). Specifications of Sustainable development and climate change, Surendra Publications
Pipe, Jim (2011). Specifications of Planet Earth: Weather and Climate, Octopus Publishing Group.
Sutcliffe, R. C, 1967. Weather and Climate: The Advancement of Science Series, W. W. Norton & Company.

IDE 601 DESIGN, OPERATION & EVALUATION OF PRESSURIZED IRRIGATION SYSTEM 2+1

Objective

Developing competency for hydraulic design of drip as well as sprinkler irrigation system for particular area and crop based on site situation, to develop the common understanding of filtration unit in drip and sprinkler irrigation and able to estimate the fertilizer requirement for particular crop, able to assess the cost effective drip and sprinkler irrigation system for particular area and crop.

Theory

UNIT I

Filtration units, drip fertigation, Distribution uniformity of water, Pressure distribution in the system, Cost economics of different systems, Evaluation of micro and sprinkler irrigation system

UNIT II

Basic hydraulics of sprinkler and drip system, Pipe flow analysis, Friction losses and pressure variation

UNIT III

Flow in nozzles and emitters, Design of sprinkler drip and micro irrigation system in relation to source, soil, climate and topographical conditions

UNIT IV

Selection of pipe sizes, pumps and power units, layout distribution, efficiency and economics

UNIT V

Fertilizing through sprinkler and drip system. Pressurized irrigation networks system (PINs)

Practical

Evaluation of various uniformities, Evaluation of pressure distribution, Efficiencies of filtration, Fertigation efficiency, and also based on theory and recent advances in the field.

Suggested Readings

Sivanappan, R.K. (1987). Sprinkler Irrigation. Oxford and IBH Publishing Co. New Delhi.
Finkel, H.J. (1983). Handbook of Irrigation Technology Vol. I CRC Press, Florida, USA.
Karmeli, D., Peri, G. and Todes, M. (1985). Irrigation Systems: Design and Operation. Oxford University Press. Captown.
Sivanappn, R.K. Padmakumari, O. and Kumar V. (1987). Drip Irrigation. Keerthy Publishing House Coimbature.
Pillsbury, A.F. (1972). Sprinkler Irrigation, FAO Agricultural Development Paper No. 88, FAO, Rome.

Mane & B. L. Ayare, Design Operation of Drip Irrigation, Jain Publications.
Mane & B. L. Ayare, Design Operation of Sprinkler Irrigation, Jain Publications.

IDE 602 ADVANCES IN IRRIGATION AND DRAINAGE 3+0

Objective

After completion of course student will be familiar about Advance methods of Irrigation and Drainage, drainage material and various sources of agricultural pollution, able to develop and apply simulation model for management of drainage system for particular area.

Theory

UNIT I

Advances in surface irrigation systems-surge irrigation : effect of surging on surface flow hydraulics, cablegation: water supply management.

UNIT II

Atomization in sprinkler and micro irrigation systems; multipurpose and special uses of micro irrigation.

UNIT III

Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.

UNIT IV

Controlled drainage for reducing agricultural non point pollution . Application of simulation models for drainage systems.

Suggested Readings

FAO. 1082. Mechanized Sprinkler Irrigation. FAO Irrigation and Drainage Paper 35.
FAO. 1989. Guidelines for Designing and Evaluating Surface Irrigation System.FAO Irrigation and Drainage paper 45.
Keller J and Bliesner RD. 1990. Sprinkler land Trickle Irrigation. Chapman & Hall.
Ritzema HP. (Ed.) 1994. Drainage Principles and Applications. ILRI. Walker WR & Skogerboe GV. 1987. Surface Irrigation: Theory and Practice, Prentice Hall.

IDE 603 HYDRO-CHEMICAL MODELLING AND POLLUTANT MANAGEMENT 3+0

Objective

Demonstrate understanding of hydrodynamics of fluid and pollutant transport through modelling, capable to do water quality analysis of lakes and reservoir based physical and chemical characteristics, develop water reclamation and water reuse plans for irrigation and industries.

Theory

UNIT I

Hydrodynamics in flow through porous media, Hydrodynamic dispersion, diffusion, convection equation. Analytical and numerical models of contaminant transport in unsaturated soil profile and ground water.

UNIT II

Water quality management in lakes and reservoirs; physical characteristics; hydrologic and chemical budgets; bio geochemical processes of pollutants, assessment methods.

UNIT III

Classical wastewater problems; water reclamation, reuse, water quality constraints and considerations for reuse in irrigation and industry; Biological wastewater treatment.

UNIT IV

Modern stream pollution problem. Quality of groundwater and sources of contaminants. Cost economics-environment impact assessment.

Suggested Readings

Larry W Mays 1996. Water Resources Handbook. Mc Graw Hill.

Metcalf and Eddey 1994. Wastewater Treatment Engineering and Reuse. John Wiley.

Soli J Arceivala 1998. Wastewater Treatment for Pollution Control. Tata Mc Graw-Hill.

IDE 604 PLANT GROWTH MODELLING & SIMULATION 2+1

Objective

After completion of course student will be able to know various plant growth models and their application based on input environmental parameters, student will acquainted with generalized agricultural simulator.

Theory

UNIT I

Introduction to plant growth modelling, Simulation and simulation language

UNIT II

Types of models and modelling approaches, Relational diagram of principle process

UNIT III

Structure of a generalized agricultural simulator, Input environment and techniques for monitoring plant environment, Process and aspects of growth and development, Input yield models

UNIT IV

Quantitative analysis of photosynthesis, respiration, growth, water and nutrient uptake, Yield functions. Remote sensing based modelling.

Practical

Identification of growth parameters, familiarization and use of different instruments used for investigation of various plant and crop parameters and their uses in respective measurements, usefulness of modelling and simulation studies, Field variability of growth influencing factors, Controlled environment experiments and their use, undertaking of the functioning of DSSAT, CERES, CROPWAT, SWACROP or other model, Model testing, calibration and validation.

Suggested Readings

Nobel, P.S. (1991). Physicochemical and Environment Plant Phsiology. Academic Press Inc. San Diego, CA, USA.

Goudriaan, J and Van Laar, H.H. (1994). Modelling Potential Crop Growth Process. Kluweer Academic Publisher, Dordrecht, Netherlands.

Levitt, J. (1972). Responses of Plants to Environment Stress. Academic Press, New York. USA.

Evans, L.T. (1963). Environmental Control of Plant Growth. Academic Press, New Yor, USA.

Charls-Edwards, D.A. (1981). The Mathematics of Photosysnthesis and Productivity Academic Press, London

Jones, J.W. and Ritchie, J.T. (1990). Crop Growth Models. In: ASAE Monograph on Management of Farm Irrigation Systems, Editted by:G.J. Hoffman, T.A. Howell and K.H. Solomon, ASAE, St. Joseph, Michigan, USA

IDE 605 FLOW THROUGH POROUS MEDIA 2+0

Objective

To acquaint and equip with the hydraulics and process of water flow in the water bearing formation under saturated as well as unsaturated conditions.

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 Readings

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 606 ADVANCED HYDO-MECHANICS IN SOIL AQUIFER SYSTEMS 3+0

Objective

To acquaint and equip the students with the advance soil-aquifer-water mechanics and various techniques for the analysis of the system.

Theory

UNIT I

Soil aquifer system. Flow of water in partially saturated soils. Partial differential equation of flow.

UNIT II

Determination of unsaturated hydraulic conductivity and models for its estimation.

UNIT III

Infiltration and exfiltration from soils in absence and presence of water table. Movement of groundwater in fractured and swelling porous media.

UNIT IV

Spatial variability. Theory of krigging. Statistical approaches in soil water dynamics.

Suggested Readings

Kirkham & Powers.1972. Advanced Soil Physics. John Wiley & Sons.

Muskut M.1937. The Flow of Homogeneous Fluid through Porous Media. McGraw Hill.

IDE 607 **COMMAND AREA DEVELOPMENT** **2+1**

Objective

Able to understand the concept of command area and its development, able to analyze problem diagnostics and remedies of command area, able to understand the performance evaluation procedure if command area.

Theory

UNIT I

Concept of command area development as an integrated approach

UNIT II

Command area project formulation, Major, medium and minor projects, various clearances involved for project approval

UNIT III

Command areas in India, Command area activities and their prioritization,

UNIT IV

Source of budget for CAD works, Structure of command area development organization, legal aspects of natural resource development

UNIT V

Partnership among developers, managers and users of natural resources in a command area, Diagnostic analysis and perform appraisal of command area projects.

Practical

Study of canal, tank and tube well in a command area, Study of design and operational parameters of a command area, Study of water balance in a command, Study the impact of command area project on crop yield and environment, Conflict resolution through PRA exercise, Diagnostic analysis of the problems of command area through PRA and field observations, Analysis of equity in water distribution, Considerations for preparation of rostering schedules, Study of the functioning of irrigation cooperatives/water user‟s associations, Preparation of command area development plan.

Suggested Readings

Kumar, P. (1977). Economics of Water Management. Heritage Publishers, New Delhi.

Garg, S.K. (1987). Hydraology and water resources engineering, Khanna Publishers, Delhi.

Michael, A.M. (2006). Irrigation theory and practice. Vikas Publications, New Delhi.

Sharma, R.K. (1987). Hydrology and water resources engineering, Dhanpat Rai & Sons, New Delhi.

IRRIGATION AND DRAINAGE ENGINEERING

List of Journals

- Journal of Irrigation and Drainage Engineering
- Agricultural Water Management
- Irrigation Science
- Irrigation and Drainage
- Irrigation and Drainage (ICID Bulletin)
- Journal of Soil Salinity and Water Quality
- Current Advances in Agricultural Sciences
- Current Science
- Ecology, Environment and Conservation
- Environmental Science and Pollution Research
- Hydrological Processes
- Hydrology Research
- Hydrological Sciences Journal
- Indian Journal of Dryland Agricultural Research & Development
- Indian Journal of Soil Conservation
- International Journal of Agricultural Engineering
- Journal of Agricultural and Environmental Ethics
- Journal of Contaminant Hydrology
- Water Research
- Water Resources Research
- Ground Water
- Advances in Water Resources

Suggested Broad Topics for Master's and Doctoral Research

- Irrigation scheduling for crops
- Evapotranspiration modeling
- Waste land development
- Irrigation water quality
- Plant growth modeling
- Command area development
- Simulation models for drainage systems
- Socio-economic impact of drainage system

SUGGESTED MINOR/SUPPORTING COURSES

Some identified Minor/Supporting courses

Course code	Course Title	Credits
CE 501	OPEN CHANNEL FLOW	3+0
CE 502	DAMS & RESERVOIR OPERATIONS	3+1
CE 503	WATER QUALITY AND POLLUTION CONTROL	3+1
CE 504	FLUVIAL HYDRAULICS	2+1
CE 505	EXPERIMENTAL STRESS ANALYSIS	2+1
CE 506	SIMILITUDE IN ENGINEERING	2+1
CE 507	CONTROL OF POLLUTION FROM SOLID WASTES	2+0
CE 601	PROBABILISTIC APPROACH IN DESIGN	2+0
CE 602	RANDOM VIBRATIONS	2+0
CE 603	DESIGN OF BINS AND SILOS	2+1
CSE 501	COMPUTER GRAPHICS	2+1
CSE 502	NEURAL NETWORK AND ITS APPLICATIONS	2+1
EE 501	APPLIED INSTRUMENTATION	2+1
EE 502	PROCESS CONTROL SYSTEMS	2+1
ME 501	MECHANISM ANALYSIS AND SYNTHESES	3+0
ME 502	VIBRATIONS	3+0

Civil Engineering

CE 501 OPEN CHANNEL FLOW 3+0

Objective

To acquaint and equip with different techniques of Open Channel Flow and its importance in the engineering

Theory

UNIT I

Open channel and their properties. Energy and momentum principles. Critical flow computations and applications.

UNIT II

Uniform flow. Its development. Formula and design computation.

UNIT III

Boundary layer concept. Surface roughness. Velocity distribution and instability of uniform flow.

UNIT IV

Gradually varied flow theory and analysis. Method of computations.

UNIT V

Hydraulic jump and its use as levelling energy dissipation.

UNIT VI

Spatially varied flow. Unsteady flow. Rapidly varied flow.

Suggested Readings

Henderson FM.1966. *Open Channel Flow*. Macmillan.
Subramaninum 1960. *Open Channel Flow*. McGraw Hill.
Ven T Chow. 1959. *Open Channel Flow*. McGraw Hill

CE 502 DAMS & RESERVOIR OPERATIONS 3+1

Objective

To acquaint and equip with different types of dams, their design philosophies and use.

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

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

UNIT IV

Foundation treatment. Abutment grunting. Instrumentation in dams.

UNIT V

Spill way and spillway capacities and spillway gates.

UNIT VI

Reservoir planning, Storage, sedimentation, Losses, Economics. Flood routing.

Practical

Exercises on above topics

Suggested Readings

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

CE 503 WATER QUALITY AND POLLUTION CONTROL 3+1

Objective

To acquaint and equip with different aspects of wastes and waste water quality, treatment and their importance

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 readings

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 and Reuse. Tata McGraw* Hill

CE 504 FLUVIAL HYDRAULICS 2+1

Objective

To acquaint and equip the students with different aspects of Fluvial Hydraulics and their importance in the engineering

Theory

UNIT I

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

UNIT II

Regimes of flow. Resistance to flow.

UNIT III

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

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 Readings

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

CE 505 EXPERIMENTAL STRESS ANALYSIS 2+1

Objective

To acquaint and equip students with different techniques/methods of stress analysis and its importance in Engineering

Theory

UNIT I

Strain and stress, Strain relationship, Strain gauges mechanical, optical, electrical, acoustical and pneumatic etc and their use. Different types of electric strain gauges, Semiconductor gauges.

Practical

Measurement of strain with strain gauge. Photo elastic methods and Moire's apparatus

Suggested Readings

Srinath LS.1984. *Experimental Stress Analysis*. Tata McGraw Hill.
Singh Sadhu. 1982. *Experimental Stress Analysis*. Khanna Publ.
Dally J.W. & W.F. Riley, 1990. *Experimental Stress Analysis*. Tata McGraw Hill

CE 506 SIMILITUDE IN ENGINEERING 2+1

Objective

To acquaint and equip the students with different aspects of similitude in Engineering and its importance in engineering

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 Readings

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

CE 507 CONTROL OF POLLUTION FROM SOLID WASTES 2+0

Objective

To acquaint and equip the students with different methods for management of solid wastes and their importance

Theory

UNIT I
Definition. Sources. Quality, Classification and characteristics of solid
waste collection, Transport and reduction at source.
UNIT II
Handling, Collection , Storage, transport of Solid wastes.
UNIT III
Disposal methods and their merits and demerits.
UNIT IV
Processing of solid wastes. Fertilizers, fuel and food values.

UNIT V
Recycling and reuse materials and energy recovery operations

Suggested Readings

Kreith F & Tchobanoglous G. 2002.*Handbook of Solid Waste Management*. McGraw Hill.
Ramachandra TV. 2006. *Management of Municipal Solid Waste*. Capital Publ. Co

CE 601 PROBABILISTIC APPROACH IN DESIGN 2+0

Objective

To acquaint and equip the students with different probabilistic methods for dynamic loading design

Theory

UNIT I

Review of various approaches in engineering design and introduction of probabilistic approach.

UNIT II

Random variables. Probability distribution and density functions. Expected values, Mean. Variance, Conditional probability. Characteristic functions.

UNIT III

Function of random variable. Concepts of stationary, ergodic and non- stationary processes.

UNIT IV

Auto correlation. Cross-correlation. Covariance functions. Power spectral and cross spectral density functions and their determination from experimental data.

UNIT V

Broad-band and Narrow band random processes., White noise. Application in various disciplines of engineering

Suggested Readings

Benjamin JR & Allen C. 1975. *Probability Statistics and Decision for Civil Engineers*. MGH New York.
Evan DH.1992. *Probability and its Applications for Engineers*. ASQC Press & Marcel Dekker

CE 602 RANDOM VIBRATIONS 2+0

Objective

To acquaint and equip the students with design by linear and nonlinear random loading analysis

Theory

UNIT I

Response to linear single and multi-degree of freedom system to stationary and non-stationary random excitation.

UNIT II

Response of continuous systems. Normal mode method.

UNIT III

Non-linear random vibration. Level crossing. Peak and envelope statistics. First excursion land fatigue failures.

UNIT IV

Applications to mechanical, aero, civil, ocean and agricultural engineering systems

Suggested Readings

Benjamin JR & Allen C. 1975. *Probability Statistics and Decision for Civil Engineers.* MGH New York.
Lipson C & Shets NJ. 1973. *Statistical Design and Analysis of Engineering Experiments*. McGraw Hill.
Subra Suresh. 1998. *Fatigue of Materials*. Cambridge Univ. Press

CE 603 DESIGN OF BINS AND SILOS 2+1

Objective

To acquaint and equip the students with Design practices for optimum design of grains storage structures

Theory

UNIT I

Computer aided design manuals. Rankine's and Coloumb's theories of active and passive pressures.

UNIT II

Janssen's and Airy's theories grain pressure theories for design of deep and shallow silos. Reimbert's theory of silo design.

UNIT III

Comparison of Australian (AS) and Indian (BIS) design criteria for bins and silos.

UNIT IV

Computer aided design of grain silos by developing flowcharts and programs for underground and over ground silos

Practical

Analysis and design of silos of various capacities using available software. Use of different standard codes and theories in the development of flowcharts and design program for various capacity silos

Suggested Readings

AS-3774.1990. *Loads on Bulk Solid Containers*.
BS-5061.1974. Specifications for Cylindrical Storage Tower Silos and Recommendations for their use. BIS Relevant Standards.
Rajgopalan K. 1989. *Storage Structure*. Oxford & IBH.
Reimbert M & Reimbert A.1956. *Design of Bins*

Mechanical Engineering

ME 501 MECHANISM ANALYSIS AND SYNTHESIS 3+0

Objective

To acquaint and equip the students with important area for analysis and design of Farm Machinery Mechanism

Theory

UNIT I

Introduction to kinematics of mechanisms, kinematic analysis and synthesis, mobility and degree of freedom of a mechanism, systematic of mechanisms deriving other mechanisms from linkages.

UNIT II

Relative motion, instantaneous center method, Kennedy's theorem. Graphical and analytical methods of displacement, velocity and acceleration analysis, Computer – Aided analysis of mechanisms.

UNIT III

Dimensional synthesis of linkages for path generation, function generation and rigid-body guidance problems. Graphical techniques. Relative pole method and method of inversion etc. Analytical kinematics synthesis of linkages, Freudenstein's method, Loop closure equations based on complex
variable approach

UNIT IV

Kinematics of gears-Analysis of epicyclic gear trains. Synthesis of gear trainscompound and epicyclic. Cam – follower system; standard follower motions and combinations, importance of follower acceleration in cam system dynamics, terms related to cam deisgn- their importance. Cam synthesis – graphical cam profile layout for a desired follower motion. Analytical determination of cam profile co-ordinates for disc cam operating common types of follower.

Suggested Readings

George N Sandor & Arthur G Erdman.1984. *Advanced Mechanism Design - Analysis and Synthesis.* Vols. I, II. Prentice Hall.

Norton. 2003. *Design of Machinery - An Introduction to the Synthesis and Analysis of Mechanisms and Machines.* McGraw Hill.

Shigley Vicker. 2007. *Theory of Machines and Mechanisms*. McGraw Hill.

Soni AH. 1974. *Mechanism Synthesis and Analysis*. McGraw Hill.

ME 502 VIBRATIONS **3+0**

Objective

To acquaint and equip the students with Significant field in the study and Analysis of farm machinery dynamics

Theory

UNIT I

Vibration motion and its terminology. Undamped free vibrations, equations of motion-natural frequency. Energy method, Rayleigh method; effective mass Principle of Virtual work. Equivalent spring stiffness in parallel and in series. Harmonic analysis and Fourier Series. Damping – viscous, solid, coulomb equivalent dampers. Viscosity damped free vibrations, Logarithmic decrement. Forced vibrations with harmonic excitation and rotating unbalance, Energy dissipated by damping. Forced vibration with damping, Vibration isolation and force and motion transmissibility.

UNIT II

Two degree of freedom systems. Principal modes of vibration, co-ordinate coupling. Vibration absorbers, Free vibration equation of motion for multi- degree of freedom systems. Influence coefficients and Maxwell's reciprocal theorem, stiffness coefficients. Numerical methods for finding natural frequencies for multi degree of freedom systems.

UNIT III

Vibration of lumped parameter systems and continuous systems. Lagrange equations. Vibration measuring instruments: Vibrometers, velocity pickups, Accelerometer and frequency measuring instruments. Applications of vibrations.

Suggested Readings

Grover GK.1996. *Mechanical Vibrations*. New Chand & Bros., Roorkee.
Rao SS. 2005. *Mechanical Vibration*. John Wiley.
William T Thomson.2004. *Theory of Vibration with Application*. 5th Ed. Marie Dillon Dahleh Amazon Co

Computer Science & Electrical Engineering

EE 501 APPLIED INSTRUMENTATION 2+1

Objective

To acquaint and equip the students with various types of transducers for study and analysis of various variables

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 Readings

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

EE 502 PROCESS CONTROL SYSTEM 2+1

Objective
To acquaint and equip the students about the concepts involved in process control system to control variables at the desired level

Theory
UNIT I
Introduction to Process Control - Controlled Variable, Control strategy, Single Variable and multi variable control systems, Process Control loop, Open loop and closed loop control system, Linear and non linear control system, Transfer function and procedure for determining the Transfer function of Complex Control System, Representation of a Control System by block diagram and its Reduction
UNIT II
Characteristics of real Process - Process Equation, Controlling & Controlled Variable, Transient & steady state response, Self Regulation Property, Control System Parameters, Evaluation of Control System.
UNIT III
Improved Control through Complex Control of process - Controller Modes or actions, On/OFF Mode, Proportional Mode, Integral Mode, Derivative Mode, Composite Control Mode (PD, PI, PID, Modes).
UNIT IV
Analysis of Common loop, involving - Flow control (Solid, liquid and gaseous flow), Pressure regulation (Pressure Transducers), Liquid level (Mechanical & Electrical Systems), Temperature Control (Thermistor and thermocouple).
UNIT V
Introduction to Computer Control of Process Application and design - Signal Conditioning, Design of OP AMPS circuits used to implement Proportional Integral, Derivative and Composite Modes. Study of various computer Controlled Electrical and Mechanical Systems.

Practical
Study of various controllers by using Op-Amps, Use of microprocessors in process control.

Suggested Readings
Johnson CD.1977. *Process Control Instrumentation Technology*. PPH.
Manke BS.2006. *Linear Control System*. Khanna Publishers

CSE 501 COMPUTER GRAPHICS 2+1

Objective
To acquaint and equip the students with the under lined concepts for generating various geometrical shapes and processing them

Theory
UNIT I
Graphic display devices, Interactive devices, Line and circle plotting techniques by using Bresenham's algorithm, Windowing and clipping, Sutherland Cophen 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 Readings
Hearn Donald.1996. *Computer Graphics*. PHI.
Schaum. Series. 2004. *Computer Graphics*. TMH

CSE 502 NEURAL NETWORK AND ITS APPLICATIONS 2+1

Objective
To acquaint and equip the students about the concepts of neural network for solving engineering problems

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

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

Course code	Course Title	Credits
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

Course Contents

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

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 COMMUNICATIONS SKILLS 0+1

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

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 Readings

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 (e-Course) INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE 1+0

Objective

The main objective of this course is to equip students and stakeholders with nowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy

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 bio-diversity 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 Readings

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, 2003

PGS 504 BASICCONCEPTS IN LABORATORYTECHNIQUES 0+1

Objective
To acquaint the students about the basics of commonly used techniques in laboratory

Practical
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; 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 Readings
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 (e-Course) AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0

Objective
To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government

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 Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes

Suggested Readings

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 (e-Course) DISASTER MANAGEMENT 1+0

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building

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 Readings

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.