PG-Curriculum

(Structure and Course Contents)

Water Resources Engineering

with effect from 2022-23 session

EXPLORE INNOVATE EXCEL

Civil Engineering Department
Punjab Engineering College
(Deemed to be University)
Chandigarh

Semester I			Semester II		
S.No.	**Courses**	**Credits**	**S. No.**	**Courses**	**Credits**
1	**Engineering Mathematics**	**3**	**1**	**DCC-IV**	**3**
2	**DCC-I**	**3**	**2**	**DCC-V**	**3**
3	**DCC-II**	**3**	**3**	**DCC-VI**	**3**
4	**DCC-III**	**3**	**4**	**DEC-II**	**3**
5	**DEC-I**	**3**	**5**	**Open Elective-I**	**3**
6	**Soft-Computing/Soft Skills and Management**	**3**	**6**	**Industrial Tour**	**0**
Total		**18**	**7**	**Design of Experiments and Research Methodology**	**3**
			Total		**18**

Semester III			Semester IV		
S.No.	**Courses**	**Credits**	**S. No.**	**Courses**	**Credits**
1	**Seminar and Report Writing**	**2**	**1**	**Dissertation-II**	**18**
2	**Research and Publication Ethics**	**2**	**Total**		**18**
3	**Dissertation-I**	**14**			
Total		**18**			

Total Credits = 18 + 18 + 18 + 18 = 72

PG Curriculum Structure

Semester I			
Sr. No.	**Course Stream**	**Course Name**	**Credits**
1	Engineering Mathematics	Engineering Mathematics	3
2	Deptt Core Course (DCC-I)	Applied Hydrology	3
3	Deptt Core Course (DCC-II)	Water Resources, Planning & Management	3
4	Deptt Core Course (DCC-III)	Advanced Fluid Mechanics	3
5	Deptt Elective Course (DEC-I)	• Flood Control & River Training Works • Hydro Power Engineering • Irrigation & Drainage Engineering	3
6	Research Methodology	Design of Experiments and Research Methodology	3
Total Credits			**18**
Semester II			
Sr. No.	**Course Stream**	**Course Name**	**Credits**
1	Deptt Core Course (DCC-IV)	Open Channel Hydraulics	3
2	Deptt Core Course (DCC-V)	Applied Hydrogeology	3
3	Deptt Core Course (DCC-VI)	Design of Hydraulic Structures	3

4	Deptt Elective Course (DEC-II)	• Applied Remote Sensing and GIS • Engineering Geology	3
5	Open Elective -I	• Geostatistics for Spatial Analysis • Climate change and Water Resources	3
6	Industrial Tour	Industrial Tour	0
7	Soft-Computing/Soft Skills and Management	Soft-Computing/Soft Skills and Management	3
Total Credits			**18**

Semester III			
Sr. No.	**Course Stream**	**Course Name**	**Credits**
1	Seminar and Report writing	Seminar and Report writing	2
2	Research and Publication Ethics	Research and Publication Ethics	2
3	Dissertation - I	Dissertation - I	14
Total Credits			**18**
Semester IV			
Sr. No.	**Course Stream**	**Course Name**	**Credits**
1	Dissertation - II	Dissertation - II	18
Total Credits			**18**

Semester-I
Program Core

Course Name	:	Applied Hydrology
Course Code	:	DCC-I
Credits	:	3
L T P	:	3-0-0

Total No. of Lectures-42

Course Objectives:

The main Objectives of this course are:	
1	To introduce the fundamentals of hydrological models.
2	To apply stochastic hydrological concepts in solving Water resources problems.

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	Hydrologic Processes Hydrologic Cycle, Systems Concept, Hydrologic System Model, Hydrologic Model Classification, Atmospheric Circulation, Evaporation, Evapotranspiration	2
2.	Subsurface Water Unsaturated Flow, Infiltration, Green-Ampt Method, Ponding Time	3
3	Surface Water Sources of Streamflow, Streamflow Hydrograph, Abstractions Using Infiltration Equations, SCS Method for Abstractions, Flow Depth and Velocity, Travel Time, Stream Networks, Hydrologic Measurement	4
4	Unit Hydrograph Response Functions of Linear Systems, Unit Hydrograph Derivation, Unit Hydrograph Application, Synthetic Unit Hydrograph, Unit Hydrographs for Different Rainfall Durations.	4
5	Hydrologic Analysis Probabilistic Treatment of Hydrologic Data, Statistical Parameters, Fitting a Probability Distribution, Probability Distributions for Hydrologic Variables, Return Period, Extreme Value Distributions, Probability Plotting, Reliability of Analysis	6
6	Linear Stochastic Models Data Generation and Assumptions, Linear Autoregressive Models, Variance of independent variables, Autoregressive moving-average ARMA model, Autoregressive integrated moving-average ARIMA model	5

7	Hydrologic Design Hydrologic Design Scale, Selection of the Design Level, First Order Analysis of Uncertainty, Composite Risk Analysis, Risk Analysis of Safety Margins and Safety Factors	4
8	Design Storms Design Precipitation Depth, Intensity-duration-frequency Relationships, Design Hyetographs from Storm Event Analysis, Design Precipitation Hyetographs from IDF Relationships, Estimated Limiting Storms, Calculation of Probable Maximum Precipitation.	4
9	Queueing theory and Reservoir storage Moran's theory of reservoirs, Steady state probabilities, Serial Correlation and Seasonal Changes in Inflows, Serially correlated inflows, Application of bivariate Markov chain.	4
9	Decision theory Probabilistic approaches to decision making, application of Bayes' theorem, Use of discrete probabilities, Use of probability functions	2
10	Hydrologic project	4

Course Outcomes:

At the completion of this course, students will be able to:	
1	analyze the precipitation data for hydrological design
2	apply the stochastic hydrological models in solving hydrological problems
3	apply probabilistic concepts in making decisions

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Applied Hydrology; K.N. Mutreja, Tata – Mc-Graw Hill.	1990
2	Hydrology for Engineers, Linsley, Kohler, Mc-Graw Hill.	1989
3	Handbook of Applied Hydrology, V.T.Chaw	1988
4	Enginneering Hydrology, E.M.Wilson, Macmillan	1990
5	Engineering Hydrology ,K.Subramanya, Tata Mc-Graw Hill	1994

Mooc courses:
https://nptel.ac.in/downloads/105101002/

https://nptel.ac.in/courses/105101002/

Course Name	:	Water Resources, Planning & Management
Course Code	:	DCC-II
Credits	:	3
L T P	:	3-0-0

Total No. of Lectures: 42

Course Objectives:

The main Objectives of this course are:	
1	to develop system thinking in water resources planning.
2	to carryout uncertainty and reliability analysis in water resources planning and management

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	Introduction Water Resources System, Types of Systems, Issues in hydro system engineering, Systems Analysis, Design versus analysis.	4
2	Systems Techniques in Water Resources Linear Programming, Dynamic Programming, Simulation, Combination of Simulation and Optimization	4
3	Water resources Economics Engineering economics, Choosing Among Feasible Alternatives, Cost-effectiveness analysis, Benefit-cost analysis, Discount Rate	4
4	Demand Consumer's Problem, Demand, Elasticity of demand, Conditions of Project Optimality, Benefit Cost Analysis.	4
5	Supply Theory of firm, The Firm's Problem, Optimal input combinations, Opportunity Cost, Average Cost Pricing, Demand, Supply, and Market Equilibrium, Criteria for Decision Making,	4
6	Reservoir Systems Reservoir Sizing, Reservoir Operation, Chance Constrained Linear Programming, Concept of Reliability, Stochastic Dynamic Programming for Reservoir Operation	4
7	Uncertainty and Reliability Analysis of Hydrosystems Rules of Probability Computation, Random Variables and Their Distributions, Analysis of Uncertainties, Reliability Computations, Direct Integration Method, Methods Using Safety, Time-to-Failure Analysis, Availability and Unavailability. Optimization of Reliability, Reliability	6
8	Surface Water Systems Surface Water Reservoir Systems, Storage-Film Yield Analysis for Water Supply, Optimization Procedures for Firm Yield Analysis, Storage-Finn Energy Analysis, Reservoir Simulation	4

9	Water Distribution Systems Distribution System Components, Network Simulation, Optimization Models for Design of Branched Systems, Optimization Models for Design of Looped Systems, Water Distribution System Reliability	4
10	Project	4

Course Outcomes:

At the completion of this course, students will be able to:	
1	apply concepts of system thinking in water resources project planning
2	carryout uncertainty analysis in project planning
3	to apply optimization methods in finding out optimal solution to water resources management

Bibliography

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Water Resources Systems Engineering, Hall and Dracup, Mc-Graw Hill.	1990
2	Economics of Water Resources Planning, James – Lee, Mc-Graw Hill	1991
3	Water Resources Engineering, Linsley and Franzini, Mc-Graw Hill.	2013
4	Optimization Theory and Applications, S.S.Rao, Wiliey East. Ltd.	1998

Mooc Course:

https://nptel.ac.in/courses/105108081/

Course Name	:	Advanced Fluid Mechanics
Course Code	:	DCC-III
Credits	:	3
L T P	:	2-0-2

Total no. lectures- 28
Total No. of Lab Hours- 28

Course Objectives:

	The main Objectives of this course are:
1.	to analyse flow kinematics with fluid flow governing laws
2.	to introduce the governing equations, laminar flow, turbulent flow and measurements of turbulence.
3.	to learn the concept of boundary layer formation in laminar and turbulent flow on different boundary shape.

Course Content:

S. No.	Course Contents	No. of Lectures/Tutorials
1	Kinematics of Flow: Equation of continuity in Cartesian, polar and cylindrical coordinates, rate of deformation, dilation, vorticity	3
2	Standard 2D Flow Patterns: Source, sink, doublet and their combinations, construction of flows by superposition, D. Alembert's paradox.	3
3	Laplace Equation: Solution by graphical and relaxation methods, conformal mapping, solution by separation of variables.	3
4	Laminar Flow: Derivation of Navier-Stokes equations, exact solutions for flow between parallel plates, Couette flow, flow near a suddenly accelerated plate and an oscillating plate.	5
5	Boundary Layers: Similarity solutions of boundary layer equations, Falkner-Skan Wedge flows, Karman's momentum integral equations, Karman – Puhlhausen approximate solution, separation in boundary layer under adverse pressure gradient, turbulent boundary layer.	5
6	Turbulent Flows: Reynolds equations of motion, semi-empirical theories of turbulence, velocity profiles for inner, outer and overlap layers, equilibrium boundary layers.	5
7	Measurement of Turbulence and Statistical Theory of Turbulence: Isotropic and homogeneous turbulence, probability density functions, correlation coefficients, decay of isotropic turbulence.	4

Lab Work:

S.No.	Lab Contents	No. of Hours
1.	To find the Drag Coefficient of flow past a cylinder	2
2.	To study the boundary layer velocity profile and to determine the exponent in the power law of velocity distribution, boundary layer thickness and displacement thickness.	4
3.	To study on Fall Velocity of an objects & to develop a relationship b/w coefficient of drag and Reynolds number.	3
4.	Energy Loss in Bends	3
5.	Analysis of Distribution Network using related software	4
6.	Project related to mathematical and practical application of fluid flow problems	8
7.	Flow visualization techniques in fluid flow	2
8.	To determine the gross characteristics of a submerged jet	2

Course Outcomes:

At the completion of this course, students will be able to:

1.	possess skills to take up research activities involving fluid mechanics.
2.	apply the learned techniques in real life problems related to fluid mechanics.
3.	analyze flow field in a variety of practical situations without going for physical model setup.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Fluid Mechanics", White, F.M., McGraw-Hill.	2015
2.	"Boundary Layer Theory", Schlichting, H., McGraw-Hill.	2014
3.	"Turbulent Flow", Garde, R.J., Wiley Eastern.	1994
4.	"Turbulent Flows", Pope, S. B., Cambridge University Press.	2000
5.	“Fluid Mechanics”, Ojha, C.S.P., Berndtsson, R. and Chandramouli, P.N., Oxford University Press.	2010
6.	“An Introduction to Turbulent Flow”, Mathieu. M.J., and Scott, F., CUP Publisher.	2000

Classical Books:

S. No.	Name of the Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Advanced Mechanics of Fluids", Rouse, H., John Wiley.	1959
2.	“Foundation of Fluid Mechanics”, Yuan, S.W., Prentice Hall	1967

Semester-II

Program Core

Course Name	:	Open Channel Hydraulics
Course Code	:	DCC-IV
Credits	:	3
L T P	:	2-0-2

Total no. lectures/Tutorials- 28
Total No. of Lab Hours- 28

Course Objectives:

	The main Objectives of this course are:
1.	to analyse open channel flow under different channel conditions
2.	to analyse varied flow condition in space and time
3.	to design hydraulic structures considering flow profile over it

Course Content:

S. No.	Course Contents	No. of Lectures/Tutorials
1	Channel Fundamentals General Flow Relationships, Uniform Flow Relationships, Theoretical Considerations, Natural, Compound, or Sustainable Channels, Lined Channels, Optimum Channels, and Velocity Constraints, Basic Design Procedures,	2
2	Specific Energy Specific Energy Diagram, Choke, Contractions and Expansions with Head Loss, Critical Depth in Nonrectangular Sections, Overbank Flow, Weirs	3
3	Uniform Flow Dimensional Analysis, Momentum Analysis, Turbulence and Flow Resistance, Uniform Flow Computations, Partly Full Flow in Smooth, Circular Conduits, Gravity Sewer Design, Compound Channels, Flood Control Channels.	4
4	Gradually Varied Flow Energy Preliminaries – Velocity Profiles and Boundary Effects, Lake Discharge Problem, Longer Transitions – Gradually Varied Flow Analyses	4
5	Momentum Hydraulic Jump, Stilling Basins, Surges, Bridge Piers, Spur Dikes, Supercritical Transitions.	3
6	Flow in Alluvial Channels Sediment Properties, Initiation of Motion, Application to Stable Channel Design, Bed Forms, Sediment Discharge, Stream bed Adjustments and Scour.	3
7	Spatially Varied Flows: Outflow from Side Weirs, Solution to Side Weir Outflow,Spatially Varied Flow in Nonprismatic Channels,	3
8	Governing Equations of Unsteady Flow Derivation of Saint-Venant Equations, Transformation to Characteristic Form, Mathematical Interpretation of Characteristics, Initial and Boundary Conditions, Dam-Break Problem. Numerical Solution of the Unsteady Flow Equations.	3

9	Hydraulic Structures Spillways, Spillway Aeration, Stepped Spillways, Culverts,	3

Lab Work:

Lab Contents		No. of Hours
1.	To study the velocity distribution in an open channel and to estimate the energy and momentum correction factors.	2
2.	To find the critical depth & surface profile using broad crested weir.	2
3.	To study the characteristics of a hydraulic jump for a constant and variable bed slope	4
4.	To study the boundary layer velocity profile and to determine the exponent in the power law of velocity distribution, boundary layer thickness and displacement thickness.	4
5.	Computation of Back Water and Draw Down Curves in a gradually varied flow	4
6.	Project related to mathematical and practical application of Free Surface Flow.	8
7.	Flow through transition in an open channel	2
8.	Design and analysis of side weir	2

Course Outcomes:

At the completion of this course, students will be able to:	
1.	apply the open channel flow concepts in designing channel under different flow conditions
2.	design hydraulic structures on the basis of evolved flow relationships and analysis
3.	to analyse different flow conditions over space and time

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	“Open Channel Hydraulics”, Chow, V.T., McGraw Hill.	2017
2	"Open-Channel Flows", Chaudhary, M.H., Prentice-Hall.	1994
3	“Flow Through Open Channels”, Ranga Raju, K.G., Tata McGraw Hill.	2003
4	“The Hydraulics of Open Channel Flow: An Introduction”, Chanson, H., Elsevier.	2004
5	"Open-Channel Hydraulics", French, R.H., McGraw-Hill.	1994
6	“Air entrainment in free-surface flows”, Wood, I.R., Balkema.	1991

Course Name	:	Applied Hydrogeology
Course Code	:	DCC-V
Credits	:	3
L T P	:	3-0-0

Total No. of Lectures: 42

Course Objectives:

The main Objectives of this course are:	
1	to introduce concept of hydrogeology and its analytical methods
2	to learn the principles of ground water flow

Course Content:

Sl. No.	Course Content	No. of Lectures/Tutorials
1	Introduction Hydrology and Hydrogeology, Groundwater Availability, Groundwater System, Planning and Management of Groundwater, Groundwater Sustainability	2
2	Hydrogeologic properties Vertical Distribution of Subsurface Water, Aquifers, Aquitards, and Aquicludes, Types of Aquifers, Groundwater Balance Aquifer Characteristics, Storage in the Unsaturated Zone, Karst Aquifer, Characteristics of Karst Aquifer. Ground water exploration methods.	4
3	Principles of Ground-Water Flow Hydraulic Head, Hydraulic Conductivity and its measurement, Darcy's Law, Ground-Water Flow in Confined and unconfined Aquifers, Homogeneous and Isotropic Systems, Transmissivity, Dupuit–Forchheimer Theory of Free-Surface Flow, Flownets	4
4	Statistical Methods in Groundwater Hydrology Distribution functions, Errors, Estimating Quantiles, Probability/Frequency/Recurrence Interval,	2
5	Time Series Analysis Parameter Estimation, Method of Moments, Method of L-Moments, Method of Least Squares, Method of Maximum Likelihood, Autoregressive Modeling, Time Series Forecasting	3
6	Hydraulics of Groundwater Continuity Equation, Equation of Motion in Groundwater, Wells, Steady Flow into a Well, Unsteady State in a Confined Aquifer, Multiple-well Systems, Design of Wells, Well Construction	4
7	Soil Moisture and Ground-Water Recharge Porosity and Water Content of Soil, Pore-Water Tension in the Vadose Zone, Theory of Unsaturated Flow, Water-Table Recharge	2
8	Groundwater Quality Groundwater Constituents and Contaminants, Groundwater Solubility,	5

	Disequilibrium and Saturation Index, Sources of Groundwater Contamination, Mass Transport of Dissolved Contaminants, Modeling Contaminant Release	
9	Groundwater Modeling Analytical Modeling, Numerical Modeling, Finite-Difference Method, Finite Volume Method, Simulation of Groundwater Flow	4
10	Groundwater Planning and Management Simulation Techniques, Optimization Models for Groundwater Management, Optimization Techniques, Groundwater Systems Economics	4
11	Surface Water and Groundwater Interaction Bank Storage and Baseflow Recession, Groundwater and Lakes, Conjunctive Use of Surface and Groundwater, Operation of Groundwater Resources in Semiarid Region	4
12	Hydrgeologic Project	4

Course Outcomes:

At the completion of this course, students will be able to:	
1	apply learned methods of hydrogeology flows in solving real life problem
2	estimate the ground water potential of the region under given conditions.
3	carryout ground water modeling

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Johnsons – Groundwater and wells – Johnson and Johnson Publication.	1986
2	Todd. D.K. Groundwater Hydrology – Wiley.	2007
3	H.M.Raghunath, Ground Water – Wiley Eastern Ltd	2007

Mooc Courses:

https://nptel.ac.in/courses/105103026

Course Name	Design of Hydraulic Structures
Course Code	DCC-VI
Credits	3
L T P	3 - 0 - 0
Course Objectives:	
1. To know the basics of Hydraulic structures along with the design of different components associated with them. 2. To convey the knowledge on the causes of failure, design criteria, and stability analysis of different types of dams.	

Total No. of Lectures: 42

Sl. No.	Course Content	No. of Lectures/Tutorials
1	Planning and investigations of reservoir and dam sites Choice of dam, preparation and protection of foundation and abutments	4
2	Forces acting on solid gravity dam, modes of failures, stability analysis, the elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam joints, seals, keys in gravity dams, dam safety and hazard mitigation	8
3	Homogeneous and Zoned embankment dams, factors influencing design of embankment dams, the criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through body and dam foundation, classification of rockfill dams and their design considerations.	8
4	Capacity of Spillways, Components and profile of different types of spillways, non-conventional types of spillways, selection and design of energy dissipaters	7
5	Components of diversion headwork and their functions, design of weirs and barrages on permeable foundations	7
6	Canal regulation structures and design of cross drainage works, canal drops, operation and maintenance of canals	6
7	Review of codes of practice	2

Course Outcomes Students can be able
1. To integrate relevant concepts and methodologies in the area of hydraulics, hydrology, and geotechnical engineering. 2. To explain the causes of failure of different types of dams and their design criteria.

3. To design the various hydraulic structures on the basis of designed flood flow and their proper regulations.
4. To design minor irrigation structures such as regulators, cross drainage works, and canal falls.

Suggested Books		
S.No.	Name of Book/Authors/Publishers	Year of Publication/Reprint
1	USBR, “Design of gravity dams”, A Water ResourcesTechnical Publication, Denver,Colorado	1976
2	USBR, "Design of small dams", A water resources technicalpublication, Oxford and IBH publishing co., New Delhi	1974
3	Creager W P, Justin J D and Hinds J., "Engineering for dams"Nemchand and Brothers, Roorkee	1995
4	Khatsuria R M. “Hydraulics of spillways and energy dissipators", CRC Press	2005
5	Novak P. *Hydraulic Structures",Taylor and Francis Grouppublishers	2001

Deptt. Elective

Course Name	:	Hydro Power Engineering
Course Code	:	DEC-I
Credits	:	3
L T P	:	3-0-0

Total no. lectures: 42

Course Objectives:

	The main Objectives of this course are:
1.	to estimate hydropower potential in a river basin.
2.	to estimate dependable flow under different river flow conditions
3.	to carryout surges analysis in hydro power generation

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Water Power: Introduction, sources of energy, role of hydropower in a power system	3
2	Estimation of Water Power Potential: Flow duration curves of gauge and ungauged streams, load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load. Design and Analysis: To procure hydrological data of a river basin and to analyze it for estimation of primary and secondary power.	5
3	Types of Hydro-power Plants: Run of river plants, general arrangement of run of river plants, valley dam plants, diversion canal plants, high head diversion plants, storage and pondage, pumped storage power plants.	5
4	Penstocks: General classification, design criteria, economical diameter, losses, anchor blocks, valves, bends and manifolds.	5
5	Trash racks: Types, losses, design, stability.	5
6	Intakes: Types, losses, air entrainment, anti-vortex device, air vent, power channels, forebay, and tunnel.	5
7	Turbines: Introduction, types of turbines, hydraulics of turbines, velocity triangles, draft tubes, cavitation in turbines, turbine model testing, characteristics of turbines.	5
8	Water Hammer and Surges: Introduction, water hammer, transients caused by turbine, load acceptance and rejection, resonance in penstocks, surge tanks, channel surges.	5
9	Project	4

Course Outcomes:

At the completion of this course, students will be able to:	
1.	determine hydro power potential of a river
2.	determine appropriate location of Hydro Power plant
3.	analyze the water hammer and surge phenomenon in hydro power generation.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Water Power Engineering", Dandekar, M.M., and Sharma, K.H., Vikas Publishing House Pvt Ltd.	2016
2.	"Hydro Power Structures", Varshney, R.S., Nem Chand & Bros.	2001
3.	"Hydro Electric Engineering", Nigam, P.S., Nem Chand & Bros.	2001
4.	"Applied Hydraulic Transients", Choudhary, M.H., Van Nostrand Reinhold Company	2014
5.	"Fluid Transients", Streeter, V.L., and Wylie, B., McGraw-Hill Book Company.	2013
6.	Norwegian Institute of Technology: Hydropower Development: Vols. 3, 4, 5 & 6, Division of Hydraulic Engineering.	1992-93

Classical Books:

S.No.	Name of the Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Water Power Engineering", Barrows, H.K., Tata McGraw Hill Publishing Company Ltd.	1980
2.	"Hydropower Engineering", Warnick, C.C., Prentice-Hall.	1984

MOOC'S on this course are available at:

1. https://www.mooc-list.com/tags/hydropower

Course Name	:	Flood Control & River Training Works
Course Code	:	DEC-I
Credits	:	3
L T P	:	3 0 0

Total no. lectures: 42

Course Objectives:

	The main Objectives of this course are:
1.	to study the flood flow & its prevention by using hydraulic structures.
2.	to design the flood control structure and excess flood prevention
3.	to get acquainted with the guidelines for planning and design of river training works.

Course Contents:

S.No.	Course Contents	No. of Lectures
1	Alluvial streams and their hydraulic geometry, bed level variation of alluvial streams, variation in plan form of alluvial streams	5
2	Analytical models of river morphology, Numerical models for morphological studies, flood plain analysis and morphology of some Indian rivers.	5
3	Computational of peak floods, flood frequency analysis Case Study: To analyze peak flood using hydrological data of a watershed and visit to Water Resources Engineering Department	5
4	Floods in major Indian river basin, types and design of flood forecasting and protection systems and basic software's for flood modeling and forecasting.	5
5	Stochastic Hydrology, probabilistic analysis.	5
6	Operational hydrology, reservoir operation for flood control and management, flood damage estimation models.	5
7	Guide lines for planning and design of river training works and maintenance of river training works and bank protections for alluvial rivers.	5
8	Application of Geo- synthetics in river training works.	3
9	Project	4

Course Outcomes:

At the completion of this course, students will be able to:	
1.	analyze the peak floods of given basin.
2.	estimate flood damage under different conditions
3.	develop flood forecasting methods under different hydrological conditions

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	BIS 107051(1994), 12094 (2000), 12926 (1995), 8408 (1994)	-
2.	"Mechanics of sediment transportation and alluvial streams problems", Garde R J and Ranga Raju K G , New age International Limited Publishers, New Delhi	2000
3.	"River Morphology", Garde R J , New Age International Publishers, New Delhi	2006
4.	"Hydraulic Design Handbook", Mays Larry W., Mc Graw Hill Companies, New Delhi	1999
5.	"Applied Hydrology" Mutreja K.N. Tata McGraw-Hill Publishing company Ltd., New Delhi	1990
6.	"Elementary Hydrology", Singh Vijay. P, Prentice Hall, India	1992

Classical Book

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Applied Hydrology", Chow V T, Maidment David R and Mays Larry W, McGraw-Hill Book Company, New Delhi	1988

MOOC'S on this course are available at:

1. https://www.nptel.ac.in/courses/10S10S110/38

Course Name	:	Irrigation & Drainage Engineering
Course Code	:	DEC-I
Credits	:	3
L T P	:	3-0-0

Total no. lectures: 42

Course Objectives:

	The main Objectives of this course are:
1	to introduce the basic concepts of Irrigation engineering and its use in crop production with the help of canal network system including drainage aspects.
2	to explore the importance of irrigation and drainage practices and management
3	to learn about distribution systems of canal irrigation

Course Contents:

S. No.	Course Contents	No. of Lectures
1.	INTRODUCTION Impact of Irrigation on Human Environment, Need of Irrigation, Development of Irrigation in India, Major and Medium Irrigation Schemes of India, Command Area Development, Planning of Irrigation Projects, Crops and Crop Seasons	4
2	SOIL-WATER RELATIONS AND IRRIGATION METHODS Physical Properties of Soil, Chemical Properties of Soil, Soil-Water Relationships, Root-Zone Soil Water, Infiltration, Consumptive Use, Irrigation Requirement, Methods of Irrigation, Quality of Irrigation Water	4
3	CANAL IRRIGATION Command Areas, Planning of an Irrigation Canal System, Alignment of Irrigation Canals, Duty of Water, Estimation of Design Discharge of a Canal, Canal Regulation, Assessment of Charges of Irrigation Water, Waterlogging, Drainage of Irrigated Lands	4
4	MANAGEMENT OF CANAL IRRIGATION Need for Canal Irrigation Management, Inadequacies of Canal Irrigation Management, Objectives and Criteria for Good Canal Irrigation Management, Operation and Maintenance of Canal Irrigation Systems, Evaluation of Performance of Canal Irrigation Systems	4
5	DESIGN OF STABLE CHANNELS Rigid Boundary Channels carrying Clear Water, Rigid Boundary Channels carrying Sediment-laden Water, Alluvial Channels Carrying Clear Water, Alluvial Channels Carrying Sediment-laden Water, Design of Irrigation Channels, Borrow Pits, Spoil Banks, and Land Width for Irrigation Channel, Sediment Distribution in an Alluvial Channel, Silting and Berming of Channels	5
6	CANAL REGULATION STRUCTURES Canal Fall, Types of Canal Falls, Roughening Measures for Energy Dissipation, Distributary Head Regulator, Cross Regulator, Design Criteria for Distributary Head Regulator and Cross Regulator, Control of Sediment Entry into an Offtaking Channel, Canal Escapes	5
7	CROSS-DRAINAGE STRUCTURES Need of Cross-Drainage Structures, Types of Cross-Drainage Structures, Selection of Suitable Types of Cross-Drainage Structure, Design of Cross-Drainage Structures, Design of Transitions for Canal Waterway	4
8	CANAL HEADWORKS Location of Headworks on Rivers, Weir, Barrage, Undersluices, Afflux, Waterway, and	4

	Different Levels for Weir Construction, Divide Wall, Head Regulator, Sediment Control in Canals	
9	RIVERS AND RIVER TRAINING METHODS Classification of Rivers, Behaviour of Rivers, River Training, River Training Methods	4
10	Project	4

Course Outcomes:

At the completion of this course, students will be able to:	
1.	do assessment of crop water requirement
2.	do optimum scheduling of irrigation
3.	manage soil salinity problems and leaching process

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Irrigation Engineering" by Bharat S., Nem Chand & Bros.	2005
2	"Irrigation Theory & Practice", by Michael, A.M, Vikas Publishing House, New Delhi.	2009
3	"Irrigation Water Management", by Majumdar, D.K., PHI Learning	2014
4	"Irrigation and Drainage Engg.", Waller, P., and Yitayew, M., Springer	2016

MOOC'S on this course are available at:

1. http://onlinecourses.nptel.ac.in/noc18_ar07/preview
2. https://www.mooc-list.com/tags/irrigation-techniques

Course Name	:	Applied Remote Sensing and GIS
Course Code	:	DEC-II
Credits	:	3
L T P	:	2-0-2

Total no. lectures: 28
Total No. of Practicals: 28

Course Objectives:

	The main Objectives of this course are:
1.	to enhance the concepts of digital mapping
2.	to apply remote sensing & GIS techniques in water resources
3.	to develop alternate methods of resources estimation using remote sensing

Course Contents:

S.No.	Course Contents	No. of Lectures
1	Modern Trends in Surveying and Mapping: Digital Mapping, Uses and applications, data collection techniques (Conventional and Non-conventional), Present Status in India and abroad	3
2	Aerial Photogrammetry Introduction, types, Stereoscopy, Scale of a photograph, flight planning, Mosaics	5
3	Geographical Information System (GIS) Introduction, advantages, objectives of GIS, Definitions of GIS, Components of GIS, Overlay analysis, Digital Terrain Modeling, Digital Elevation Model Applications of GIS in various engineering fields	5
4	Physics of Remote Sensing: Introduction, EM spectrum, Ideal RS System, Real RS System, Visual Image interpretation, active and passive remote sensing, Reflectance; spectral reflectance of land covers; Spectral characteristics of solar radiation; energy interaction in the atmosphere; energy interactions with the Earth's surface, Spectral reflectance curves, Resolution	5
5	Digital Image Processing (DIP) applicable in Water Resources Engineering Introduction, Histogram and image statistics, Remote Sensing Image distortion and rectification: Radiometric errors and Geometric errors. Image Enhancement techniques, Image classification – Supervised and Unsupervised classification	6
6	Global Positioning System Introduction, GPS, DGPS, Applications in Engineering	4

Practical		
1.	Geo-registering and geo referencing	4
2	Image enhancement	4
3	Image classification methods	4
4	Thematic layers overlay operations	4
5	Case studies	12

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Enhance the knowledge related to recent advancements in surveying
2.	Understand various terms in Geospatial Industry and relate with applications of RS/GIS in Smart City initiatives and in water resources field
3.	Acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modeling and monitoring

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Geomatics Engineering", byManoj Arora and R C Barjatiya, Nem Chand Brothers, Roorkee.	2011
2	"Principles of GIS", by Peter A. Burrough, Rachael A., Oxford University Press	2014
3	"Remote Sensing and Image Interpretation", by Lilysand T.M., and Kiefer R.W, Wiley Publishers	2010
4	"Introduction to GIS",byKang-tsung Chang, Tata McGraw Hill, 5th Edition	2016
5	"Introduction to Remote sensing", by Campbell & Wynne, Guilford Press	2014
6	"Essential Image Processing and GIS for Remote Sensing", Liu, J.G., and Mason, P., Wiley	2009
7	"Integration of remote sensing & GIS", Victor, Wiley	2007

MOOC'S on this course are available at:

1. https://onlinecourses.nptel.ac.in/noc17-ce1S/preview
2. https://ww.courseera.org/lecture/gis-applications/remote-sensing

Course Name	:	Engineering Geology
Course Code	:	DEC-II
Credits	:	3
L T P	:	2 0 2

Total no. lectures- 28
Total Lab Hours-28

Course Objectives:

	The main Objectives of this course are:
1.	To enhance megascopic and microscopic knowledge of mineral and rocks in turn.
2.	To importance of Geomorphic principles operated in the past, aerial photo-interpretation and its use in identification of different Landforms
3.	To understand significance of Landslides and Structural features in engineering construction. Critically examine role of Geological considerations in Civil Engineering Structures.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Mineralogy and Geo-mechanics: Important rock forming minerals, their megascopic and Microscopic properties. Outline classification, mode of formation & occurrence of important Rock groups (Sedimentary, Igneous and Metamorphic).	5
2	Geomorphology: Principles of geomorphology, occurrence of ground water in different rock types. Geo-photo interpretation of Aerial photograph. Application in highway planning and water resources field, Analysis of land forms, soil types, vegetative cover, Land forms (glacial, arid and fluvial), Snow cover features from aerial photographs.	5
3	Engineering Problems: Landslides: cause, classification, zonation and protection, subsidence and related phenomenon, structure of rocks (folds, faults, joints, and unconformity) and their significance in Engineering construction, foundation problems in different types of rocks. Geological considerations related to water Resources Engineering in the selection of site for dams, reservoirs, tunnels, abutments, buildings and air fields. Sensor driven/controlled dams/tunnels. Road stones and suitability of various rocks for road use.	18

Lab Work:

S. No.	Lab Contents	No. of Hours
1	Identification of Crystal forms	4
2	Microscopic studies of important rocks and minerals through thin section slides	6
3	Studies of representative aerial photographs under Mirror Stereoscope	6
4	Understand Geological maps & their utility in the Civil Engineering Projects	6
5	Draw structural & cross sectional profiles from the Geological map.	6

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Ascertain rocks and know their occurrence
2.	Distinguish minerals in hand specimen and under the microscope
3.	Use aerial photographs for interpretation of different landforms and to apply knowledge of geological structures in engineering construction.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"The Dynamic Earth-An Introduction to Physical Geology", Skinner, B.J. and Porter, S.C. John Wiley and Sons, N.Y.	2000
2.	"A Geology for Engineers", Blyth, F.G.H. and de Freitas, M.H. CRC Press.	1994

Classical Books

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Engineering Geology", Goodman, R.E. John Wiley and Sons, NY	1993

MOOC'S on this course are available at:

1. https://www.nptelvideos.in/2012/11/engineering-geology.html
2. https://www.engineering.unsw.edu.au/study/postgraduate/geotechnicalengineering

Open Elective

Course Name	:	Geostatistics for Spatial Analysis
Course Code	:	
Credits	:	03
L T P	:	2-0-2

Total No. of Lectures– 28, Practical -28

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the concept of Geostatistics
2	To make the students able to apply Spatial Analysis tools in solving real life problems.

Course contents:

S. No	Course Contents	No. of Lectures
1	Introduction to geostatistics, Generalizing, Description, Interpretation, Control	02
2	Basic Statistics: Measurement and summary, The normal distribution, Covariance and correlation, Transformations, Exploratory data analysis and display, Sampling and estimation,	04
3	Prediction and Interpolation: Spatial interpolation, Thiessen polygons, Triangulation, Natural neighbour interpolation, Inverse functions of distance , Trend surfaces, Splines	04
4	Characterizing Spatial Processes: The Covariance, and Variogram, stochastic approach to spatial variation, Random variables, Spatial covariance, Stationarity, Ergodicity, Quasi-stationarity, Characteristics of the spatial correlation functions, variogram, Estimating semivariances and covariances, The experimental covariance function	04
5	Modelling the Variogram Limitations on variogram functions, Unbounded random variation, Combining models, Periodicity, Anisotropy, Fitting models	04
6	Reliability of the Experimental Variogram and Nested Sampling Reliability of the experimental variogram, Statistical distribution, Sample size and design, Sample spacing, Theory of nested sampling and analysis, Case study	04
7	Local Estimation or Prediction: Kriging General characteristics of kriging, Kinds of kriging, Theory of ordinary kriging, Weights , Kriging at the centre of the lattice, Kriging off-centre in the lattice and at a sampling point , Kriging from irregularly spaced data, Neighbourhood, Ordinary kriging for mapping, Case study	04

S. No	Practical Contents	No. of contact hours
1	Spatial data compilation on GIS platform	4
2	Case study about random variable of interest	4
3	Construction of experimental variogram	4
4	Fitting variogram and estimating semivariance	8
5	Apply variogram in predicting variable of interest with kriging	8

Course Outcomes:

At the end of the course, students will be able to:	
1	To conceptualize and formulate the existing natural resources case with geostatistics
2	To apply the geostatistics in carrying out spatial analysis of a case undertaken
3	To get acquainted with available gestatistics softwares

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"Multivariate Geostatistics: An Introduction with Applications, Hans Wackernagel, Publisher: Springer Berlin Heidelberg	2013
2	"Basic Linear Geostatistics", Margaret Armstrong, Publisher: Springer Berlin Heidelberg	2012
3	"Geostatistics for natural resources evaluation", Pierre Goovaerts, Oxford University Press,	1997

Course Name	:	Climate change and Water Resources
Course Code	:	
Credits	:	03
L T P	:	3-0-0

Total No. of Lectures – 42

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the climate change and its effect on available natural resources.
2	To make the students able to detect and analyze uncertainty in climate change.

Course contents:

S. No.	Course Contents	No. of Lectures
1.	Global Climate System, Energy Balance, and the Hydrological Cycle, weather and climate, regional climate downscaling	04
2.	Climate Variability and Change, Detection and Attribution of Climate Change	04
3.	Uncertainty in Climate Change, Climate Change Impacts on natural resources	04
4.	Statistical Analysis of Climate change	10
5	Spatial and temporal analysis of Climate change	10
6	Economics of Climate Change, Climate Change Vulnerability Assessment	5
7	Managing Climate Risk for the Water resources, Transboundary River Systems in the Context of Climate Change	5

Course Outcomes:

By the end of the course, the students will be able to:	
1.	carry out Climate Change Vulnerability Assessment
2.	analyze Climate Change Impacts on Water Resources
3.	carryout risk assessment of climate change

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	Renewable Energy and Climate Change, Volker Quaschning, John Wiley & Sons Publication Ltd.	2010
2	Modelling the impact of climate change on water resources, Fai Fung, Ana Lopez, Mark New, Blackwell Publishing Ltd.	2011

Course Name	:	**Design of Experiments and Research Methodology**
Course Code	:	
Credits	:	**3**
L T P	:	**3 0 0**

Course Objectives

The main Objectives of this course are:	
1	To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data Collection and the interpretation to the students.
2	To make the students understand the concept of research, need for research, types of research and steps in conducting research.

Total Nos. of Lectures: 42

Course Contents:

S. No.	Course Contents	No. of Lectures
1	**Introduction:** Principles of design of experiment, Methodology for design of experiment, Screening design, Factorial design, Randomized design.	**3**
2	**Sample & Estimation:** Population, Sample, Probability in sampling, sampling with replacement, parameters of samples.	**3**
3	**Probability and random variables:** Bayesian probability, conditional probability, Bayes theorem, statistical independence of events, random variables- discrete and continuous, probability distribution functions, cumulative distribution functions, Expectation and variance of a random variable, joint distribution of two random variables and their correlation.	**6**
4	**Statistics for Engineers:** Discrete & Continuous distributions, different distributions functions application in engineering, distribution estimation & its assessment.	**6**
5	**Simulation:** Monte Carlo method, Queuing theory, Markovian process.	**3**
6	**Random Variables Data Analysis:** Single and multi- variables data analysis, estimation of parameters, spline smoothing, residual analysis, ANOVA.	**6**
7	**Modelling:** Introduction to modelling, types of models, development of mathematical models	**3**
8	**Geostatistics:** Introduction to Geostatistics, Geostatistical data analysis methods.	**4**
9	**Stochastic Processes:** Time series analysis, model identification, forecast and uncertainty analysis.	**4**
10	**Research Report Writing:** Purpose and nature of research, Research ethics Research proposal and literature review, Defining the problem, Finding and managing information, Developing and stating hypotheses. Research report, writing a thesis, writing for publication.	**4**

Course Outcomes:

At the completion of this course, students will be able to:	
1	Make use of various Research methodologies and its applications in the relevant field of engineering.
2	Organize and conduct research in a more appropriate manner.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Probability and Statistics for Engineers and scientists, Walpole, Myers, MyersandYe, Pearson Education.	7th edition, 2002
2	Statistics in Research, Bernand Ostleand Richard N. Mensing, Oxford & IBH Pub Co.	3rd edition,1975
3	Probability and Statistics in Engineering, Hines, Montgomery, Gold sman and Borror, John Wiley & Sons.	4th edition, 2003
4	Experimental design, Theory & application, Federer, Oxford & IBH pub Co.	1955
5	Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA	2014

MOOCs on this course are available at:

1. http://professional.mit.edu/programs/short-programs/design-and-analysis-experiments
   By Prof. Paul Berger, MIT Professional Education

2. https://nptel.ac.in/courses/107108011/
   By Prof. Amaresh Chakraborty, Indian Institute of Science, Bangalore