

VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI



Scheme of Teaching and Examinations and Syllabus
M.Tech. in Water and Land Management (20WLM)
(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech in Water and Land Management (20WLM)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
Sl. No	Course	Course Code	Course Title	Theory	Practical	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
				03	--	02	03	40	60	100	4
2	PCC	20 WLM12	Surface Water Hydrology	03	--	02	03	40	60	100	4
3	PCC	20WLM13	Hydraulic Structures	03	--	02	03	40	60	100	4
4	PCC	20WLM14	Remote Sensing and Geographic Information System	03	--	02	03	40	60	100	4
5	PCC	20WLM15	Water Pollution: Control, Treatment and Management	03	--	02	03	40	60	100	4
6	PCC	20WLML16	Hydro-Soil Engg. Lab	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	02	--	--	03	40	60	100	2
TOTAL				17	04	10	21	280	420	700	24

Note: PCC: Professional core.

Skill development activities:

Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.

The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.

The students shall

- (1) Gain confidence in modelling of systems and algorithms.
- (2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
- (3) Handle advanced instruments to enhance technical talent.
- (4) Involve in case studies and field visits/ field work.
- (5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.

(ii) Three credit courses are designed for 40 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ seminar	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20WLM 21	Watershed: Planning and Management	03	--	02	03	40	60	100	4
2	PCC	20WLM 22	Groundwater Hydrology	03	--	02	03	40	60	100	4
3	PCC	20WLM23	Solid Waste Engineering & Management	03	--	02	03	40	60	100	4
4	PEC	20WLM24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20WLM25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20WLM26	Geospatial Technology Laboratory	--	04	--	03	40	60	100	2
7	PCC	20WLM27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				17	06	06	18	340	360	700	24

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		Professional Elective 2	
Course Code under 20XXX24X	Course title	Course Code under 20XXX25X	Course title
20WLM241	Advanced Remote Sensing	20WLM251	Irrigation Technology & Irrigation Water Management
20WLM242	Urban Flood: Planning and Management	20WLM252	Wastewater Reclamation and reuse
18WLM243	Water Quality Analysis and Modeling	20WLM253	Ground Improvement Techniques and Measures
20WLM244	River morphology	20WLM254	Open channel hydraulics

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini –Project/ Internship	Skill Development activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20WLM31	Environmental Impact Assessment	03	--	02	03	40	60	100	4
2	PEC	20WLM32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20WLM33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20WLM34	Evaluation of Project phase -1	--	02	--	--	100	--	100	2
5	PCC	20WLM35	Mini Project	--	02	--	--	100	--	100	2
6	Internship	20WLM36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				09	04	02	12	360	240	600	20

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		Professional elective 4	
Course Code under 20XXX32X	Course title	Course Code under 20XXX33X	Course title
20WLM321	Wetland management	20WLM331	Groundwater Assessment, Development & Management
20WLM322	Industrial Safety, Health, and Environmental Management	20WLM332	Water Management: Conservation, Harvesting and Artificial Recharge
20WLM323	Industrial Wastewater Management & Audit	20WLM333	Global Warming and Climate Change
20WLM324	Weather and Climate Modelling	20XXX334	Environmental Planning and Management

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship

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IV SEMESTER										
Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	20WLM41	Project work phase -2	--	04	03	40	60	100	20
TOTAL				--	04	03	40	60	100	20
Note: 1. Project Phase-2: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25. SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.										
SEE (University examination) shall be as per the University norms.										



Department of Civil Engineering

“Jnana Sangama”, Belagavi - 590 018

VISION

To be a knowledge centre in Civil Engineering education, research and consultancy field for creating sustainable environment and enhancing quality of life.

MISSION

Develop a specialized professional by imparting quality education and training. Attain international standards in teaching, education, research and consultancy through the following procedure.

- **Establishing robust, adaptive curricula**
- **Promoting interactive teaching practices in mutual learning system**
- **By creating modern educational tools and techniques**
- **Enhancing research culture to establish synergy teaching and research**
- **Exploring the Participation of industrial experts and consultancy personal to connect class room content to practical field requirement**
- **Pursueing intensification of soft skills and personality development**

QUALITY POLICY

To become the key player in nation building through the contribution of technical manpower of rich caliber with its core strength in Teaching and Research and providing service to society by imparting state of art technical education involving industrial and corporate sectors.

PROGRAM: WATER AND LAND MANAGEMENT

VISION

To be a knowledge centre in water and land management education, research and practical field for creating sustainable environment and enhancing quality of life.

MISSION

Develop a specialised professional by imparting quality education and training. Attain international standards in teaching, education, research and consultancy.

PROGRAM EDUCATIONAL OBJECTIVES

The graduating students of the Water and Land Management Program will be able to:

PEO1.	Apply knowledge of basic sciences and engineering to analyze water and Land Management practices for socio-economic development
PEO2.	Identify the sources of water, Capabilities of different soil and their characteristics.
PEO3.	Plan and design water and Land Management strategies.
PEO4.	Analyze complex field situations and provide engineering solutions for land and water management aspects.
PEO5.	Communicate effectively, and lead multidisciplinary teams to solve water related issues with professional ethics.
PEO6.	Provide scientific inputs to decision makers.

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Analyze hydro meteorological data and components of hydrological cycle
PO2	Assess surface and groundwater resources
PO3	Plan water resources projects for meeting socio-economical and environmental needs
PO4	Design and manage water resources systems for optimal utilization
PO5	Manage land and water in the changing climate scenario
PO6	Analyze hydrologic extremes and adopt suitable management practices to minimize impacts
PO7	Work and lead in multi disciplinary environment and demonstrate professional and social ethics
PO8	Engage in critical thinking and pursue lifelong learning for professional advancement

FIRST SEMESTER

OPTIMIZATION TECHNIQUES IN WATER & LAND RESOURCES [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM11	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To understand history & development of optimization concepts To formulate Linear and dynamic programming for real world problems To understand different optimization techniques available for obtaining solution for real world problems To find optimized solutions for transportation and assignment problems To learn simulation and other optimization techniques 			
Modules			Teaching Hours
Module -1			
INTRODUCTION Development of optimization techniques, nature and characteristics of operation research, methodology of optimization, applications of optimization techniques, classification of operation research model, uses and limitation of optimization techniques.			10 Hours
Module -2			
LINEAR PROGRAMMING Introduction to Linear programming, problem formulation, graphical solution, solution by simplex method, Big M and Two Phase method			10 Hours
Module -3			
TRANSPORTATION PROBLEM Introduction, mathematical formulation of problem, methods for finding initial basic feasible solution, MODI Method, degeneracy in transportation problem. ASSIGNMENT PROBLEMS Mathematical formulation, assignment algorithm methods for solving assignment problems.			10 Hours
Module -4			
SIMULATION Basic principles and concepts - Random variant and random process - Monte Carlo techniques - Model development - Inputs and outputs - Case studies.			10 Hours
Module -5			
OTHER OPTIMIZATION TECHNIQUES Dynamic programming- Introduction, Approaches, Application and case studies, Network analysis- CPM & PERT			10 Hours
Course outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Explain history & development of optimization concepts Formulate Linear and dynamic programming for real world problems 			

<ul style="list-style-type: none"> • Apply different optimization techniques available for obtaining solution for real world problems • Find optimized solutions for transportation and assignment problems • Apply optimization techniques for solving present problems related to water and land management
Text Books: <ol style="list-style-type: none"> 1. S.D. Sharma: “Operations Research” Kedar Nath Ramnath & Co. Meerut. 2. Rao, S.S. “Engineering Optimization”, John Wiley & Sons, 1996 3. Kanti Swarup, P.K. Gupta & Manmohan “Operations Research” Sultan Chand & Sons, 2014. Reference Books: <ol style="list-style-type: none"> 1. H.A. Taha: “Operations Research” Macmillan publishing Co. 2. Ravindran, D.T., Philips and Solberg, J.J. “Operation Research- Principles and practice”, Wiley Pub., 1987. 3. Hiller, F.S., and Liberman, G.J. “Introduction to operation Research”-(1992), CBS publication and Distributions, New Delhi.

SURFACE WATER HYDROLOGY [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	18WLM12	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> • To Analyze components of hydrologic cycle • To Predict hydrologic extreme events for hydraulic and hydrologic design • To Develop forecasting models for operation of hydrologic systems • To understand extent of surface water resources 			
Modules			Teaching Hours
Module -1 Introduction: Scope and importance of hydrology, Hydrologic cycle, Global and India's Water resources, Applications of hydrology. Watershed Concept: Catchment, Topographic and Ground water divide, Description of the catchment, demarking a catchment, stream patterns. Location of rain-gauges and optimum number of rain-gauges, Analysis of rainfall data, Rainfall mass curve and hyetograph, Intensity-Duration analysis, Intensity-Frequency-Duration analysis, Depth-Area-Duration analysis, Double mass curve.			10 Hours
Module -2 Abstractions from precipitation: Evaporation-Process, Measurement, Empirical equations and Estimation by Water budget method and Energy budget method. Evapo-transpiration-AET & PET, Estimation by Penman's equation, Reference Crop Evapo-transpiration by Blaney Criddle formula. Infiltration-Process, Factor affecting infiltration, Measurement, Horton's equation and Philip's equation. Infiltration indices.			10 Hours

Module -3	
Runoff:-Process, Factors affecting runoff, API, Basin yield, Curve number method, water budgeting. Correlation, Regression analysis-Simple linear and Multiple linear regression, Curvilinear regression. Classification of models, Model formulation, Lumped parameter conceptual models, Physically based models, Model performance testing.	10 Hours
Module -4	
Hydrograph and its features, Methods of hydrograph separation, Unit hydrograph and its derivation, Unit hydrographs from complex storms and for various durations, S-curve hydrograph and its uses, Synthetic unit hydrograph.	10 Hours
Module -5	
Flood: Design flood and its estimation- Rational method, Frequency analysis Gumbel's and Log-Pearson's type III distribution, Selection of design return period. Flood routing- Reservoir routing: Modified Pul's method, Goodrich method, Channel routing- Prism and Wedge storage, Muskingum method. Flood control: Structural and Non-structural measures.	10 Hours
Course outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Analyze components of hydrologic cycle Predict hydrologic extreme events for hydraulic and hydrologic design Develop forecasting models for operation of hydrologic systems Assess surface water resources 	
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: <ol style="list-style-type: none"> Subramanya K. "Engineering Hydrology", Tata McGraw Hill, 1998 Jaya Rami Reddy, P. "A text book of Hydrology", Laxmi publications, 2009 Putty, M. R.Y. "Principles of Hydrology", I.K. Int. Publishing House, New Delhi, 2010 	
Reference Books: <ol style="list-style-type: none"> Linsley R K, Kohler and Paulhus. "Hydrology for Engineers", McGraw Hill, NY, USA, 1958. Mutreja, K. N. "Applied hydrology", Tata McGraw Hill Pub. Co., New Delhi, India- 1986. Chow, V.T. "Handbook of Applied hydrology", McGraw Hill, NY, 1964 	

HYDRAULIC STRUCTURES [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM13	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To explain the factors governing site selection for construction of different hydraulic structures and procedure for report/documentation; To estimate forces to be considered for design of hydraulic structures like gravity dam, earth dam, diversion structures, regulators, canals; To analyze & design different hydraulic structures like dam, regulator, and canal. 			
Modules			Teaching Hours
Module -1 Gravity Dam: Factors governing selection of type of dam, Principle stresses, Modes of failure, stability analysis, high/low dam, elementary/ practical profile, gravity & zonal method design.			10 Hours
Module -2			
Earthen Dam: Types, general principles of design, causes of failure, analysis of seepage through earth dams, stability analysis, control of seepage.			10 Hours
Module -3			
Spillway: Types, design criteria (ogee), energy dissipaters Diversion Structures: Types, causes of failure, Bligh's Theory and Khosla's Theory,			10 Hours
Module -4			
Design of Vertical Drop Weir. Regulators: Functions of cross/head regulator, alignment, Design of Cross Regulators.			10 Hours
Module -5			
Canal System: Canal networks, Kennedy's and Lacey's theory of canal design, Introduction to Canal fall and Canal Escapes.			10 Hours
Course outcomes: <ul style="list-style-type: none"> Judge suitable sites for locating different hydraulic structures; Estimate forces to be considered for design of hydraulic structures; Analyze & design different hydraulic structures like dam, regulator, and canal. 			
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.			
Text Books: <ol style="list-style-type: none"> Modi, P.N. "Irrigation, Water Resources and Water Power Engineering" Standard Book House, New Delhi, 2nd ed, 1990. 			

2. Garg S.K, Irrigation Engineering and Hydraulic Structures, Khanna Publishers N.D. 2006.

Reference Books:-

1. Varshney “Concrete dams”— Oxford & IBH Publications, 1978
2. Creager, Justin, Hinds. “Engineering for Dams (Volume-I, II and III)” – Wiley India Publications.

REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEM [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM14	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: Students will be able to know <ul style="list-style-type: none"> • The principles of Remote Sensing and GIS • To develop spatial database for its various application • To perform various spatial analysis related to water and land management 			
Modules			Teaching Hours
Module -1 1. Remote Sensing: Remote Sensing Basic Principles: Introduction, Electromagnetic Remote Sensing Process, Physics of Radiant Energy: Nature of Electromagnetic Radiation, Electromagnetic Spectrum; Energy Source and its Characteristics, Atmospheric Interactions with Electromagnetic Radiation: Atmospheric properties, Absorption of Ozone, Atmospheric effects on Spectral Response Patterns; Energy interactions with Earth’s surface materials: Spectral Reflectance Curves; Cossine Law. Remote Sensing Platforms and Sensors: Satellite System Parameters, Sensor Parameter: Spatial Resolution, Spectral Resolution, Radiometric Resolution; Imaging Sensor Systems: Multispectral Imaging Sensor System, Thermal Sensing System, Microwave Imaging Systems; Earth Resources Satellites: Landsat Satellite Programme, SPOT Satellite, Indian Remote Sensing Satellite (IRS); Meteorological Satellites: NOAA Satellite, GOES Satellite.			10 Hours
Module -2 Visual Image Interpretation: Introduction Digital Image Processing: Introduction, Basic Character of Digital Image, Preprocessing: Geometric Correction Methods, Radiometric Geometric Correction, Atmospheric Geometric Correction; Image Enhancement Techniques: Contrast Enhancement; Spatial Filtering Techniques: Low Pass Filters, High Pass Filters, Filtering for Edge Enhancement; Image Transformations NDVI Transformation, PCA Transformation; Image Classification: Supervised Classification, Training Dataset, Unsupervised Classification.			10 Hours

Module -3	
2. Geographical Information System: Introduction to GIS: Introduction to GIS History of GIS, Early developments in GIS, Applications of GIS, Spatial Data Input and Editing: Primary Data, Secondary Data, and Data Editing. Introduction: Maps and Map Scale, Map Scale, Type of Maps, Map and Glob Geo-referencing and Projection: Understanding Earth, Coordinate System, Map Projection, Transformation, Geo-referencing	10 Hours
Module -4	
Global Positioning System (GPS): Introduction. Spatial Database Management Systems: Introduction, Data Storage, Database Structure Models, Database Management system, Entity Relationship Model, Normalization. Data Models and Data Structures: Introduction, GIS Data Model, Vector Data Structure, Raster Data structure , Geodatabase and Metadata	10 Hours
Module -5	
Spatial Analysis: Introduction to spatial analysis, Vector Operations and Analysis, Network Analysis, Raster Data Spatial Analysis. Interpolation: Introduction to Interpolation, Global Methods of Interpolation, Local Methods of Interpolation Web GIS: Introduction, Web GIS, OGC & Web Services	10 Hours
Course outcomes: On completion of this course, students are able to <ul style="list-style-type: none"> • Develop a sound understanding of the principles and function of Remote Sensing & GIS. • Understand various techniques in preparing spatial data. • Understand various spatial analysis to manage water and land 	
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: <ol style="list-style-type: none"> 1. M. Anji Reddy, 'Remote Sensing and Geographical Information Systems' 4th Edition, BS Publications. 2. Kang-Tsung Chang, 'Introduction to Geographic Information Systems', McGraw-Hill Book Company. Reference Books: <ol style="list-style-type: none"> 1. Longley, P. A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., 'Geographic Information Systems and Science', 2nd Edition, John Wiley and Sons. 2. Burrough, P. A., and McDonnell, R. A. 'Principles of Geographical Information Systems', Oxford University Press, 2nd Edition. 3. Demers, M. N., 'Fundamentals of Geographic Information Systems', John Wiley & Sons, 3rd Edition. 	

WATER POLLUTION: CONTROL, TREATMENT AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM15	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: The course is designed to train students: <ul style="list-style-type: none"> • To have thorough knowledge of Sampling ,Water Acts, National Water Policy • Effects of Industrial waste on water and land, • Sources and estimation of point and non point sources of pollution. • Geo-environmental Issues and management • Water law ,Environmental Protection Law, legislation, • Characterization of industrial Wastewater Pollutants. 			
Modules			Teaching Hours
Module -1 Introduction: Definition of Water Pollution, Cause and Sources and Consequences of Water Pollution and Remedial Measures Nature of pollutants, Ground water pollution Cause and Sources, Remedial Measures and its effect, Industrial Waste Effects: On Sewage Treatment Plant and Receiving Water Bodies, Present Scenario of River and Lake Water Pollution due to Waste Waters Discharge in India and Self Purification of Streams. Effluent Standards and Stream Standards.			10 Hours
Module -2 Wastewater & Monitoring : Existing approaches of control/abatement of water quality degradation, Concept of Material balance-methods of qualifications, wastewater Sampling: Grab, Composite and Integrated Samples. Sampling Procedure ,Stages and Preservation. Natural methods of wastewater Disposal. Monitoring: Definition- Monitoring of stream, river , lake .Types and methods of Monitoring, Stages Involved in Monitoring process, Equipments used in Monitoring Process. Concept of Continuous pH, Conductivity and Bio-monitoring. DO and BOD in streams, Transformation and transport processes, Oxygen transfer, Turbulent mixing, Flow augmentation.			10 Hours
Module -3			

<p>Point and Non-Point Source of Pollution: Point & Non – Point source pollution, Modelling approaches for Point & non – point sources.</p> <p>Models used for Surface and Ground Water quality Modelling. – Concept of Modelling, Stages, General Flow chart of Modelling process, types of Models, Application, key points, Limitations.</p>	10 Hours
Module -4	
<p>Water laws, legislation & Soil water pollution.</p> <p>Water laws & legislation – Water Act (1986), National Water Policy (CPCB). Water quality objectives and standards. riparian rights, Groundwater ownership, Environmental Protection Law, Water pollution control acts and, Legislation in India, Control Acts.</p> <p>Soil pollution, Cause, Sources, Remedial Measures and its effect, , Change in the soil behaviour properties and characteristics of soil with respect to pollutants, Soil-water-contaminant interactions and its implications – Factors effecting retention and transport of contaminants.</p>	10 Hours
Module -5	
<p>Sources, Process, Characterization, Treatment And Effects of industrial Wastewater Pollutants:</p> <p>Industries: Fertilizer, Tannery, Pulp, and Paper Mill, Dairy , Cane Sugar , Textile, Distillery and Brewery, Petrochemical industry wastewater.</p>	10 Hours
<p>Course outcomes: On completion of this course, students are able to</p> <ul style="list-style-type: none"> • Understand Wastewater characterization & Monitoring, Water Acts, Water laws & legislation. • Evaluate the Impact of industrial waste effects. • Understand the various sources of pollution and its effects. • Understand Effluent Standards and Stream Standards, sampling. • Estimate and impacts of Point and non point sources of pollution. • Surface and Ground Water quality modeling, Geo-environmental Issues and management • Characterization of industrial Wastewater Pollutants. 	
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 20 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
<p>Text Book:</p> <ol style="list-style-type: none"> 1. H.S. Peavy, D.R. Rowe, G. Tchobanoglous. Environmental Engineering, Mcgrow-Hill International Edition, 1st Edition, 2013. 2. Dr. B.C. Punmia, Arun Kumar Jain, Ashok Kumar Jain. Environmental Engineering 	

II, Laxmi Publications Pvt Limited, 2005.

Reference Books:

1. Metcalf and Eddy, A Text Book of Waste Water Engineering
2. Sparks, D.L., "Environmental Soil Chemistry" Academic Press, New York, 2002.
3. Alvarez-Benedi J. and Munoz-Carpena, R., "Soil-Water-Solute Process Characterization: An Integrated Approach" CRC Press, New York, 2005.

HYDRO-SOIL ENGINEERING LABORATORY [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLML16	IA Marks	40
Number of Teaching Hours/Week	00:04:00	Exam Marks	60
Credits	02	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To conduct laboratory studies on water and soil parameters. To investigate various physical, chemical and biological parameters of water To investigate various material testing for micro irrigation 			
Modules			
Experiment No.1: Estimation of Solids, Acidity, Alkalinity, Determination of pH and Conductivity Experiment No.2: Hardness, Chlorides and Fluorides Experiment No.3: Estimation of Phosphates and Sulphates Experiment No.4: Estimation of Residual Chlorine Experiment No.5: Determination of Available Chlorine in bleaching powder Experiment No.6: Determination of Dissolved Oxygen Experiment No.7: Measurement of Mean Emission Rate of Emitting tube Experiment No.8: Determination of Melt Flow Index Experiment No.9: Determination of Tensile Strength & Elongation of Lateral Experiment No.10: Carbon Black Dispersion test. & Carbon black content test. Experiment No.11: Resistance of emitting tube to hydrostatic pressure at ambient/ elevated temperature. Experiment No.12: Reversion Test Experiment No.13: Resistance to Pull outs of Joints between fitting and emitting tube.			
Course outcomes: On completion of this laboratory studies students are able to: <ul style="list-style-type: none"> Investigate independently the various physical, chemical and biological parameters of water and soil. 			
Reference Books: <ol style="list-style-type: none"> Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc., 2002 B. Kotaiah and Dr. N. Kumara Swamy, Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Ed., 2007. Standard methods for the examination of water and wastewater, 21st Edition, Washington: APHA., 2012 BIS Code , IS 1278: 1989, IS 13487 : 1992, IS 13488 : 1992 			
Conduction of Practical Examination: <ol style="list-style-type: none"> All laboratory experiments must be included for practical examination. Students are given two experiment to do in the examination. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks Experiment 1: Procedure + Conduction + Viva: 08 + 14 +08 (30) Experiment 2: Procedure + Conduction + Viva: 08 + 14 +08 (30) Change of experiment is allowed only once and Marks for the procedure for the alternate experiment is not given. 			

Conduction of Practical Examination:

1. All laboratory experiments must be included for practical examination.
2. Students are given two experiment to do in the examination.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks
4. **Experiment 1:** Procedure + Conduction + Viva: **08 + 14 +08 (30)**
Experiment 2: Procedure + Conduction + Viva: **08 + 14 +08 (30)**
5. **Change of experiment is allowed only once and Marks for the procedure for the alternate experiment is not given.**

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Number of Teaching Hours/Week (L:P:SDA)	02:00:00	SEE Marks	60
Credits	02	Exam Hours	03
Module-1			
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.			
Module-2			
Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs,			
Module-3			
Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.			
Module-4			
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of			

Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act 1999, Copyright Act, 1957, The Protection of Plant Varieties and Farmers' Rights Act, 2001, The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO), WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property its relevance and business impact

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.

Textbooks

- (1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018.
- (2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE Publications, 3rd Edition, 2011.
- (3) Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

- (1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
- (2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

SECOND SEMESTER

WATERSHED: PLANNING AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	18WLM21	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To understand causes and extent of soil erosion To study various possible soil conservation measures onn a watershed To know various water harvesting and groundwater recharge measures To understand the watershed cahracteristics 			
Modules			Teaching Hours
Module -1 Watershed concepts: Watershed-Topographic divide, Ground water divide, Stream patterns, Soil erosion- Problems, Types, Conservation technology, Watershed approach, Watershed Management, Factors influencing watershed operations, Watershed characteristics, Deterioration of watershed, Watershed delineation, Prioritizing watersheds, Coding of watershed, Morphometric analysis of watershed-Linear, Areal and Relief aspects, Channel networks, Hypsometric analysis.			10 Hours
Module -2 Sediment transport: Sediment-Sources, Mechanics of sediment transport, factors affecting sediment yield, Types of sediment load, Estimation of bed load and suspended sediment load. Estimation of bed load using sampler. Estimation of suspended load, Selection of sediment sampling point, Frequency of sampling, Location of sediment observation post, Collection of sediment samples, Soil loss estimation by USLE, Modified USLE, Revised USLE and other methods. Soil and water: Soil composition, Soil profile and texture, Significance of soil texture for soil conservation, Infiltration, Soil moisture, Ground water, Soil conditions for plant growth, Essential food elements required for plant growth.			10 Hours
Module -3 Land use capability classification: Soil survey, Mapping unit, Purpose of land capability classification, Soil and land use capability-classification, Capability, Limitation; Capability unit; Land capability sub classes, Land capability rating table, Identification of classes in the field, Land use capability classification, Recommended land use and Soil conservation practices for all capability classes. Erosion control measures in agriculture land: Importance, Contour bunding, Drainage of excessive water, Graded bunding, Bench Terracing, Land leveling and grading, grassed waterways.			10 Hours
Module -4 Water conservation and harvesting: Introduction, Water conservation methods for crop land, Treatment of catchments, small storage structures- Water harvesting/silt retention structures, Gully control structures, Small earth dams, spillways, Small weirs, Sand dams, Drought farm pond, Nala-bunding, Off-			10 Hours

<p>stream storage, Developing ground water- Recharge and Extraction, Water harvesting for trees and shrubs.</p> <p>Agronomical measures in soil and water conservation: Land use and Conservation agronomy, Grassland Management, Agro-forestry, Horticulture.</p> <p>Erosion control measures in Non-agricultural lands: General- Soil conservation on waste lands, Contour and Staggered trenching, Gully control structures, Sediment retention structure, Retaining walls, Gully and Ravine reclamation.</p>	
Module -5	
<p>Watershed Management: Introduction, Watershed characteristics, Causes and Consequences of watershed deterioration, Objectives, People's participation- Definition, Why to pay incentives, Mobilization of participation, People's organization, Conservation farming, Watershed management plan-General identification of watershed problems, Objectives and Priorities, Socio-economic survey, Watershed map and Preparation of format for watershed management plan.</p>	10 Hours
<p>Course outcomes: At the end of the program the student will be able to:</p> <ul style="list-style-type: none"> • Identify causes of soil erosion • Plan and design soil conservation measures in a watershed • Plan and design water harvesting and groundwater recharge structures • Can be able to identify suitable watershed practices based on objectives. 	
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Tideman, E. M., "Watershed Management", Omega Scientific Publishers, New Delhi, 2002 2. Suresh Rao, Soil and Water Conservation Practices, Standard Publishers, 2003. 3. J. V. S Murthy, Watershed Management, New Age International Publishers, 1998. 	
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Heathcote, I. W., "Integrated Watershed Management" Springer. 2. Strahler, A. H., "Modern physical geography", John Wiley & Sons, 1991. 3. V.V. N. Murthy, Land and Water Management, Kalyani Publishers, 1994. 	

GROUND WATER HYDROLOGY

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	20WLM22	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To Introduce groundwater hydrology To understand Groundwater Flow in Aquifers To Model Groundwater Flow in Aquifers To know Geophysical Methods in Groundwater Exploration 			
Modules			Teaching Hours
Module -1			
General Water Balance, Regional Ground Water Balance, Distribution of Subsurface Water, Different Types of Aquifers, Heterogeneity and Anisotropy, Occurrence of Ground Water in Hydro Geological Formations, Structure and Types of Wells. –Problems on estimation of basic parameters.			10 Hours
Module -2			
Governing Equation of Groundwater Flow in Aquifers. Derivation of General Differential Equations for Ground Water Flow, Regional Ground Water Problems, Governing Equations for Transient Flow Conditions.			10 Hours
Module -3			
Models for Ground Water Analysis: Introduction, Major Applications of Groundwater Models, Numerical Modelling of Groundwater Systems, Groundwater Modelling by the Finite Difference (FD). –Problems. Pollution of Groundwater: Hydrodynamic Dispersion of Pollutants in Groundwater Environment (Advection dispersion, Molecular diffusion) Optimization models for management of groundwater quantity and quality.			10 Hours
Module -4			
Well Hydraulics: Analysis of Steady Radial Flow Towards a Well in a confined Aquifer, Dupuit Forcheimmer (DF) Theory of free Surface Flow For Steady Flow in Unconfined Aquifers, Analysis of Steady Radial Flow in Laterlly Stratified Phreatic Aquifers. Problems on well Hydraulics.			10 Hours
Module -5			
Artificial Recharge: Spreading methods, Induced-recharge method, Recharge-well method, Subsurface dams, Wastewater discharge, Recharge by urban storm runoff, Case history. Geophysical Methods in Groundwater Exploration, Introduction, Electrical Resistivity Method, Analytical Derivation for Resistivity in Vertical Electrical Sounding, Seismic Retraction Method, Determination of Aquifer Thickness, Geologic and Hydrologic methods, Hydrogeologic well logging, Tracer techniques.			10 Hours

Course outcomes: On completion of this course, students are able to

- Apply the governing equation of groundwater flow for different cases
- Carryout physical investigation for groundwater resource
- Apply various techniques for assessment, development and management of groundwater.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books

1. A. K. Rastogi., Numerical Groundwater Hydrology, Penram International Publishing (India) Pvt.Ltd.2007.

Reference Books:

1. Todd D.K. & Mays, L.W., “Ground Water Hydrology”, 3 Ed, Wiley.
2. Raghunath H.M., “Ground Water”, New Age Publishers, 2007.

SOLID WASTE ENGINEERING AND MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	20WLM23	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> • To provide detailed knowledge and skills in solid waste management. • To provide detailed knowledge of treatment, disposal and recycling options for solid wastes. • To provide detailed knowledge of principles of existing and emerging technologies for the treatment of waste and recovery of value from waste. 			
Modules			Teaching Hours
Module -1 Solid Waste- Types, Sources and Engineering Classification, Characterization, Generation, On-Site Handling, Storage and Processing, Quantification. Collection of Solid Waste- Collection Systems, Collection Equipment, Collection Route Optimization.			10 Hours
Module -2 Transfer and Transport- Transfer Stations, Location of Transfer Stations, Transfer Means and Methods. Processing Techniques- Mechanical Volume Reduction, Thermal Volume Reduction, Manual Component Separation.			10 Hours

Module -3	
Engineering Systems for Resource and Energy Recovery - Materials-Recovery Systems, Recovery Of Biological Conversion Products, Recovery Of Thermal Conversion Products, Recovery of Energy From Conversion Products; Materials And Energy Recovery Systems, Design Examples.	10 Hours
Module -4	
Treatment Methods- Recycle, Reduce and Reuse, Composting, Incineration, Pyrolysis, Disposal Methods- Impacts Of Open Dumping, Site Selection, Sanitary Land Filling- Design Criteria, Leachate And Gas Collection Systems, Leachate Treatment, Deep-Well Injection.	10 Hours
Module -5	
Recent Developments in Solid Waste Reuse and Disposal-Power Generation, Building with Construction Materials And Best Management Practices (BMP). Biomedical Waste Management and Treatment , Present Scenario of E waste Management, Industrial Solid Waste management. Role of Various Organizations in Solid Waste Management- Governmental, Non-Governmental, Citizen Forums.	10 Hours
Course outcomes: On completion of this course, students are able to <ul style="list-style-type: none"> Understand and apply the basic scientific and sustainability principles behind waste management, for solving practical waste management challenges Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of value from waste 	
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question consists of 20marks. There will be 2full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: <ol style="list-style-type: none"> Tchobanoglous G., Theissen H., and Eliassen R., “Solid Waste Engineering Principles and Management Issues”, McGraw Hill, New York. H.S. Peavy, D.R. Rowe, G. Tchobanoglous. Environmental Engineering, Mcgrow-Hill International Edition, 1st Edition, 2013. Reference Books: <ol style="list-style-type: none"> Mantel C. L.,(1975), “Solid Waste Management”, John Wiley Pavoni J.L., “Handbook of Solid Waste Disposal”. 	

ADVANCED REMOTE SENSING [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM241	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To gain the knowledge of optical and microwave remote sensing To become familiar with the basic principles and advantages of thermal and Microwave Remote Sensing. 			
Modules			Teaching Hours
Module -1 Introduction: Definition of terms, Concepts and types of remote sensing; evolution of remote sensing technology, stages in remote sensing technology, spatial data acquisition, interdisciplinary nature and relation with other disciplines, applications of remote sensing, advantages of RS over conventional methods of survey and inventorying, Overview of RS			10 Hours
Module -2			
Basic Principles of Remote Sensing : Electromagnetic spectrum: Characteristics of electro-magnetic radiation; Interactions between matter and electro-magnetic radiation; Wavelength regions of electro-magnetic radiation; Types of remote sensing with respect to wavelength regions; active and passive remote sensing, Definition of radiometry; Black body radiation; Reflectance; spectral reflectance of land covers; Spectral characteristics of solar radiation; Radiative transfer equation; energy interaction in the atmosphere; energy interactions with the earth's surface- spectral reflectance curves.			10 Hours
Module -3			
Sensors: Types of sensors- passive sensors and active sensors; imaging systems, photographic sensors, characteristics of optical sensors; Sensor resolution- spectral, spatial, radiometric and temporal; Dispersing element; Spectroscopic filter; Spectrometer; Characteristic of optical detectors; Cameras for remote sensing; Film for remote sensing; non-imaging radiometers, imaging sensors, photograph v/s image, Panchromatic, Multispectral, hyperspectral, stereo images, Optical mechanical line scanner; Pushbroom scanner; Imaging spectrometer; spaceborne imaging sensors, active and passive microwave sensors; Thermal sensors; Atmospheric sensors; Sonar; Laser, radar, hyperspectral sensors. Products from scanner data, Image data characteristics, data selection criteria.			10 Hours
Module -4			
Platforms: Types of platforms- airborne remote sensing, space borne remote sensing; Atmospheric condition and altitude; Attitude of platform; Attitude sensors; Orbital elements of satellite; Orbit of satellite; Satellite positioning systems; satellites for Land, Ocean, and atmospheric studies.			10 Hours

Image Interpretation and Analysis: Fundamentals of satellite image interpretation; Types of imaging, elements of interpretation; Techniques of visual interpretation; Generations of Thematic maps.	
Module -5	
Digital Image Processing: Digital data manipulation and analysis; image rectification – Radiometric correction, Atmospheric correction, Geometric correction; image enhancement – Spatial feature manipulation and multi-image manipulation; classification techniques – Supervised classification and unsupervised classification. Advanced Remote Sensing Technologies: Synthetic Aperture Radar; Side Looking Airborne Radar; Hyper spectral Imaging Spectrometer; Lidar; Thermal Imaging System; Advanced Laser Terrain Mapping.	10 Hours
Course outcomes: Upon completion of this subject students should <ul style="list-style-type: none"> • have the knowledge of optical and microwave remote sensing for practical applications • Be able to apply the principles of thermal and Microwave RS to the real time problems. 	
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books <ol style="list-style-type: none"> 1. George Joseph, “Fundamentals of Remote Sensing”, Universities Press, 2005 2. P. J. Curran, “Physical aspects of Remote Sensing”, Longman Group Limited, London. 	
References Books: <ol style="list-style-type: none"> 1. F. F. Sabins, “Remote Sensing Principles and Interpretation”, Waveland Press. 2. John R Jensen “Introductory Digital Image Processing: A Remote Sensing Perspective”, Pearson Series Geographic Information Science, ISBN- 13: 978-0134058160 3. Robert A. Schowengerdt “Remote sensing Models and methods for image processing”, Second edition, 1997, Academic Press. 	

URBAN FLOOD PLANNING & MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM242	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To explain the urban flooding-its types and characteristics, influence of urban density on floods To understand the key uncertainties of climate and expected consequences of climate change To explain the types of flood damages, loss of life estimation and to explain impacts of land use change on runoff To elaborate the concept of Resilience, Vulnerability, Robustness & Sustainability of flood response To analyze and design the SUDS systems and FFWRS To acquire deeper knowledge of disaster mitigation and management 			
Modules			Teaching Hours
Module -1 Introduction: The influence of climate, causes of flooding, types of flooding, fluvial/pluvial flooding, principles of landuse planning Climate Change: Key uncertainties and Robust Findings: A review of the past, signs of change, Expected consequences.			10 Hours
Module -2			
Hydrology of cities: Urban hydrological cycle, Land use & runoff, Urban flood risk assessment, Tangible & intangible damages, Loss of life estimation in flood risk assessment, flood risk mapping			10 Hours
Module -3			
Responding to Flood Risk: Responses, Resilience, Vulnerability, Robustness & Sustainability, SPR Model, Confronting flood management with land use planning, Building types, infrastructure & public open spaces			10 Hours
Module -4			
Urban drainage systems: A historical perspective, Major & Minor flows, SUDS/LIDS, Practices in water sensitive urban design Enhancing coping & recover capacity: Flood forecasting warning and response, Emergency Planning, Management & Evacuation			10 Hours
Module -5			
Disaster mitigation & Management: Modes of disaster management, primary & secondary data, EIA of flood management structures, traffic management during floods, socio-economic studies, interdepartmental cooperation, Regional & global disaster mitigation measurement.			10 Hours
Course outcomes: At the end of the course student will be able to: <ul style="list-style-type: none"> Understand the urban flooding-its types and characteristics, influence of 			

urban density and climate change on urban floods <ul style="list-style-type: none"> • Explain the types of flood damages, loss of life estimation and to explain impacts of land use change on runoff • Analyze and design the SUDS systems and FFWRs
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.
Text Books: <ol style="list-style-type: none"> 1. Chris Zevenbergen, Adraian Cashman, Erik Pasche and Richard Ashely. "Urban Flood Management", CRC Press-2010 Edition 2. Richard Ashley, Stephen Garvin, Erik Pasche, Andreas Vassilopoulos, Chris Zevenbergen. "Advances in Urban Flood Management" CRC Press-2007 Edition. Reference Books: <ol style="list-style-type: none"> 1. Wheater, H. S., McIntyre, N., Jackson, B. M., Marshall, M. R., Ballard, C., Bulygina, N. S., Reynolds, B. and Frogbrook, Z. "Multiscale Impacts of Land Management on Flooding", Wiley-Blackwell, Oxford, UK, (2010). 2. Arun Kumar. "Handbook of Flood Management: Flood Risk Simulation, Warning, Assessment and Mitigation", SBS Publisher, India, Vol. 1 2009.

WATER QUALITY ANALYSIS AND MODELLING [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM243	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> • To know the process of pollution contaminant mechanism • To know the water quality modeling Techniques • To know water quality management measures 			
Modules			Teaching Hours
Module -1 Water quality description, various characteristics of water, Water quality criteria and standards. Elements of reaction kinetics, spatial and temporal aspects of contaminant transport, transport mechanism-advection, diffusion and dispersion.			10 Hours
Module -2 River and streams, convective diffusion equation and its applications, estuaries, estuarine hydraulics, estuarine water quality models. Lakes and reservoirs.			10 Hours

Module -3	
Contaminant transport in unsaturated variable soils, contaminant transports in ground water advection, dispersion, one dimensional transport with linear absorption	10 Hours
Module -4	
Dual porosity models, numerical models, bio-degradation reaction. Water quality management, socio-economic aspects of water quality management.	10 Hours
Module -5	
Management alternatives for water quality control, waste load allocation process. Lake quality management, ground water remediation.	10 Hours
Course outcomes: At the end of the course student will able to <ul style="list-style-type: none"> • Identify the transport of contamination • Model the water quality transport • Take the preventive measures for water quality contamination. 	
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: <ol style="list-style-type: none"> 1. Robert V. Thomann and John A. Mueller, Principles of surface water quality modelling and control. Harper & Row, 1987, ISBN 060466774, 9780060466770 2. Steven C. Chapra, "Surface water quality modelling". McGraw-Hill, 1997. ISBN: 0071152423, 9780071152426 Reference Books: <ol style="list-style-type: none"> 1. Jerald L. Schnoor, "Environmental Modelling". Publisher: John Wiley and Sons Ltd, 1996, ISBN:9780471124368 2. Thomann, "Systems Analysis and Water Quality Management". McGraw-Hill Inc.,US, ISBN-13: 978-0070642140 3. A. K. Rastogi, "Numerical Groundwater Hydrology", International Publishing (India) Pvt. Ltd. (2007). 	

SOIL EROSION AND CONSERVATION [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	18WLM	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To understand the mechanism of erosion by Water and Wind To know the method of estimation and measurement of erosion. To know soil conservation problems in Forest, Hilly, Water logged and Wetland areas. To study land and water management practices for soil conservation in Semi-arid and Arid zones of India. 			
Modules			Teaching Hours
Module -1			
Soil Erosion: Mechanism, Factors affecting, Effects Water Erosion: Mechanism, Types of erosion, Estimation and measurement of water erosion.			10 Hours
Module -2			
Hydrology: Hydrologic cycle, Factors affecting runoff, Estimation of runoff and measurement of runoff. Wind Erosion: Mechanism, Avalanching, Dunes, Factors affecting and method of estimation			10 Hours
Module -3			
Water Erosion Control: Principles, Land classification, Mechanical and Biological methods of water erosion control Wind Erosion Control: Principles, Control measures.			10 Hours
Module -4			
Soil Conservation in Special Problem Areas: Soil conservation in hilly areas, control of gullies, Rivine reclamation, Waterlogged and wetlands Forests in Soil Conservation: Forest area and its distribution, Forest types in India, National forest policy, Role of forests in soil conservation, Forest protection			10 Hours
Module -5			
Land and Water Management Practices in Semi-arid Zones: Problems of soil and water management in semi-arid zones, Management practices. Land and Water Management Practices in Arid Zones: Land and Water resources, Problems of arid zones of India, Causes of problems and control measures.			10 Hours
Course outcomes: On completion of this course, students are able to <ul style="list-style-type: none"> Estimate the soil erosion Apply the appropriate soil erosion control measures in special problem areas. Apply suitable Land and Water Management practices in Semi-arid and Arid areas. 			
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question consists of 16 marks. There will be 2full questions (with a maximum of four sub questions) from each 			

module.

- Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books

2. R.P. Tripathi, and H.P.Singh,. Soil Erosion and Conservation, New Age International (P) Ltd., Publishers.2015
3. Singh,G. Venkataramanan, C. And Sastry G. (1981). Manual of Soil and Water conservation practices in India. Central Soil and Water Conservation Research and Training Institute, Dehradun. I.C.A.R. Bulletin No. T-13/D-10
4. Rama Rao, M.S.V. (1974). Soil conservation in India, I.C.A.R., New Delhi

Reference Books:

3. Glenn, O.S., Delmar, D.F., William, J.E., Richard, K. F. Soil and Water Conservation Engineering., John Wiley & Sons (Asia) Pte Ltd, Singapore.
4. Kohake, H. And Bertrand, A.R. (1954). Soil conservation, McGraw Hill Book Co.
5. Gadkary, D.A. (1966). A manual on soil conservation. Department of agriculture, Government of Maharashtra, Pune, India.
6. Sawhney,K. And Daji, J.A. (1961). Soil and Water Conservation. Hand book of Agriculture, I.C.A.R. Publication, New Delhi.

IRRIGATION TECHNOLOGY AND IRRIGATION WATER MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM251	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> • To know about advanced techniques of irrigation in India • To understand soil water movement in the root zone of agricultural crops • To understand crop water requirement of different crops to fix the duration and frequency for irrigation. • To Know about water conveyance and reclamation of land subjected to waterlogging and salinity 			
Modules			Teaching Hours
Module -1 Introduction: Types & Techniques of Irrigation including advanced techniques, Present situation of irrigation in India Soil-Moisture Irrigation Relationship, Estimating depth and frequency of irrigation.			10 Hours
Module -2			
Soil and Land Management in Agriculture: classification and surveys-land capability farm development, grading-equipment, land management techniques			10 Hours
Module -3			
Crop requirements and irrigation scheduling : Major Indian crops times of sowing and harvesting –critical periods of growth moisture stress, Duty &			10 Hours

delta of crops, Irrigation scheduling, Consumptive use of Crop- Blanney-Criddle, Thornthwait penman, Christiansen methods, Water-use efficiency, scope of computerization in irrigation	
Module -4	
Water conveyance Computing the capacity of canals, Losses in water canals, Distribution of water into the fields through water courses, Lined canals	10 Hours
Module -5	
Reclamation of Water Logged and Saline Soils: Glances of water logging- design of surface and subsurface drains, Saline and alkaline lands reclamation and management of Salt affected lands	10 Hours
<p>Course outcomes: At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Explain advanced techniques of irrigation in India • Understand soil water movement in the root zone of agricultural crops • Fix the duration and frequency for irrigation based on crop water requirement of different crops • Describe the water conveyance and reclamation of land subjected to waterlogging and salinity 	
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Modi. P. N., Irrigation, Water Resources & Water Power Engineering- Standard Publishers, New Delhi 2. B. C. Punmia, Pande, Ashok kumar and Arunkumar Jain “Irrigation and water power engineering” Laxmi Publications (P) LTD. 3. Chaturvedi. M.C, “Water Resources Systems Planning and Management”, Tata McGraw Hill. NY <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Linsley, R. K. and Frazinini, J. B.,-“Water Resources Engineering”2nd Ed. McGraw Hill, NY 2. James L.D and Lee R.R. “Economics of Water Resources Systems Planning” McGraw Hill. NY 	

WASTEWATER RECLAMATION AND REUSE [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM252	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To provide a basic description and understanding of Wastewater Reclamation and Reuse And the principal unit processes used in the treatment of wastewater. To understand the scientific basis of each unit process, as well as the conventional approach to their engineering design. To provide an understanding of the Reuse Of Wastewater Using Arobic And Anaerobic Reactor. To provide an understanding of the Theoretical principles and design of Physical and Biological Treatment Methods. To provide an understanding of the Risk Assessment, Legal Aspects, Health Aspects in wastewater Reclamation and Reuse and Advanced Wastewater Treatment. To provide an understanding of the Recent Advancement of Wastewater Reclamation and Reuse, Rural wastewater systems. 			
Modules			Teaching Hours
Module -1 Objectives of wastewater Reclamation, Reuse and Treatment: Sources of wastewater, properties and Characteristics of wastewater, General aspects of wastewater reclamation and reuse, Reclaimed wastewater Quality, criteria, standard, guidelines. Unit Operation for wastewater and Treatment. Preliminary, Primary, Secondary Treatment, Biological Treatment and Miscellaneous Methods.			10 Hours
Module -2 Reuse Of Wastewater Using Arobic And Anaerobic Reactor. Concept of reactors used for Wastewater Treatment. Types of Reactor, Classification of Reactors, Working Principle, Merits , Demerits, Limitation , Treatment Efficiency, Field Application for Reuse of wastewater for various purposes.			10 Hours
Module -3 Theoretical principles and design of Physical Treatment Methods : Screens, equalization basin, grit chamber, primary and secondary settling tanks. Theoretical principles and design of Biological Treatment Methods: Suspended growth system - conventional activated sludge process and its modifications. Attached growth system – trickling filter, bio-towers and rotating biological contactors. Principles of stabilization ponds.			10 Hours
Module -4 Advanced Wastewater Treatment: Need and technologies used. Nitrification and De-nitrification Processes, Phosphorous Removal., Ultra-filtration, Ammonia Stripping, Wastewater Disinfection. Risk Assessment, Legal Aspects, Health Aspects in wastewater Reclamation and Reuse.			10 Hours

Module -5	
Recent Advancement of Wastewater Reclamation and Reuse : New polices, Role of Govrmental and Non Governmental Organization, Institutional Contribution , Case Studies. Scope of research in wastewater Reclamation and Reuse. Rural wastewater systems: Septic tanks, two-pit latrines, eco-toilet, soak pits.	10 Hours
Course outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> • A process flow sheet. And appropriate treatment methods for municipal and certain industrial effluents. • How water and wastewater treatment plants operate. And the Simple design equations for water and wastewater treatment plant. • The chemical and biological prociples behind unit processes used in water and wastewater treatment unit processes. And the concept of a unit operation and a unit process. • The fundamental scientific processes underlying the design and operation of wastewater treatment plant. And the management of residuals from water and wastewater treatment. • The methods that are used for the design of a water and wastewater treatment plant. • The Complete understanding of the Recent Advancement of Wastewater Reclamation and Reuse, Rural wastewater systems. • The Complete understanding of Wastewater Reclamation and Reuse And the principal unit processes used in the treatment of wastewater. • The Complete understanding the scientific basis of each unit process, as well as the conventional approach to their engineering design. • The Complete understanding of the Reuse Of Wastewater Using Arobic And Anaerobic Reactor. • The Complete understanding of the Theoretical principles and design of Physical and Biological Treatment Methods. • The Complete understanding of the Risk Assessment, Legal Aspects, Health Aspects in wastewater Reclamation and Reuse and Advanced Wastewater Treatment. • The Complete understanding of the Recent Advancement of Wastewater Reclamation and Reuse, Rural wastewater systems. 	
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 20 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
Text Books: <ol style="list-style-type: none"> 1. Metcalf and Eddy Inc., “Wastewater Engineering - Treatment and Reuse”, 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2. Karia G.L., and Christian R.A., “Wastewater Treatment Concepts and Design 	

Approach” , Prentice Hall of India Pvt. Ltd., New Delhi.

3. Ronand L., and Droste, “Theory and Practice of Water and Wastewater Treatment”, John Wiley and Sons Inc.

Reference Books:

1. Benefield R.D., and Randal C.W., “Biological Process Design for Wastewater Treatment”, Prentice Hall, Englewood Cliffs, New Jersey.
2. Lee C.C., and Lin S.D., “Handbook of Environmental Engineering Calculations”, McGraw Hill, New York.
3. “Industrial Safety and Pollution Control Handbook”, National Safety Council and Associate (Data) Publishers Pvt. Ltd.
4. “Handbook of Wastewater Reclamation and Reuse” , 1st Edition, Donald R. Rowe, Isam Mohammed Abdel-Magid

GROUND IMPROVEMENT TECHNIQUE AND MEASURES [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	18WLM253	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> • To Know Principles and objectives of ground improvement • To Study dewatering systems, filtration, drainage and seepage control with geosynthetics, preloading and vertical drains. • To apply treatment for problematic soils- collapsible and expansive soils • To study principles, concepts and mechanism of reinforced earth. 			
Modules			Teaching Hours
Module -1 Principles and objectives of ground improvement. Mechanical modifications: principles and methods of densification, properties of compacted soils, compaction control tests, deep and shallow compactions of coarse and fine grained soils – vibro- floatation, compaction piles, dynamic compaction, specification for compaction			10 Hours
Module -2 Hydraulic modifications: dewatering systems, filtration, drainage and seepage control with geosynthetics, preloading and vertical drains, electro-kinetic dewatering.			10 Hours
Module -3 Admixtures of subgrades of pavements; stabilization using industrial wastes; grouting-modification by intrusion and confinement. Stabilization: role of admixtures, methods of chemical stabilization- lime, cement, bitumen and special chemicals; mechanisms, uses and limitations.			10 Hours
Module -4			

<p>Improvement of soft grounds and low lands: treatment for problematic soils- collapsible and expansive soils, nature of problems and remedial/preventive measures.</p> <p>Reinforced earth technique: principles, concepts and mechanism of reinforced earth. Materials, design consideration for reinforced earth structures-retaining walls, embankments, bearing capacity problems and pavements. Reinforced earth construction for control of heaves. Soil nailing , design examples.</p>	10 Hours
Module -5	
<p>Geosynthetic materials: functions, property characterization, testing methods for geosynthetic materials, geotextiles, geomembranes, geogrids, geonets and geocells.</p>	10 Hours
<p>Course outcomes: At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Define Principles and objectives of ground improvement • Apply dewatering systems, filtration, drainage and seepage control with geosynthetics, preloading and vertical drains. • Apply treatment for problematic soils- collapsible and expansive soils. • Define principles, concepts and mechanism of reinforced earth. 	
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Purushotham Raj, Ground Improvement Techniques, Laxmi publications, New Delhi. 2. Hausmann, M. R., “Engineering principles of ground modification”, McGraw –Hill Pub.Co.Newyork,1990. 3. Koener R.M., “Construction and Geotechnical Methods in Foundation Engineering”, McGraw Hill Pub. Co., New York, 1985. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Ingles O.G. and Metcalf J.B., “Soil Stabilization processes and practice”, Butterworths, London, 1972. 2. Koerner R.M., “Designing with Geosynthetics”, Prentice Hall Pub.1994. 3. Bell F.G., “Ground Engineer’s Reference Book”, Butterworths, London, 1987. 	

OPEN CHANNEL HYDRULICS [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	18WLM	IA Marks	40
Number of Teaching Hours/Week	04:00:00	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To understand Pressure and Velocity distribution across channel section To study the critical depth and hydraulic exponents for flow in different channel sections. To study the uniform flow through different sections of prismatic channels. To understand the water surface profiles under gradually varied flow conditions. To understand the energy dissipation in hydraulic jump. 			
Modules			Teaching Hours
Module -1			
Basic Fluid Flow in open channel: Introduction, Classification of open channels, Classification of flow, Velocity distribution, Kinetic energy and Momentum correction factors, Pressure variation in- Still water, a channel with small slope, large slope, Pressure variation in Curvilinear flows. Flows with small water-surface curvature, Equation of continuity, Energy equation, Momentum equation.			10 Hours
Module -2			
Energy Depth Relationships: Specific energy, Critical depth, Calculation of the critical depth for Rectangular, Triangular, Circular and trapezoidal sections, Section factor, First hydraulic exponent. Transitions-Channel with hump, Transition with a change in width.			10 Hours
Module -3			
Uniform Flow: Introduction, Chezy equation, Darcy-Weisbach friction factor, Mannings formula. Velocity distribution in wide channels and Channels with small aspect ratio, Shear stress distribution, Mannings roughness coefficient, equivalent roughness, Uniform flow computations- computation of normal depth for Rectangular channel (a. Wide Rectangular Channel, b. Rectangular channel with $y_0/B \geq 0.02$), Trapezoidal Channel, Circular channel, Compound sections.			10 Hours
Module -4			
Gradually- Varied Flow: Introduction, Differential equation, Classification of flow profiles, Some features of flow profiles, Control sections. Analysis of flow profile, Transition depth.			10 Hours
Module -5			
Rapidly varied flow-Hydraulic Jump: Introduction, The momentum equation for the jump, Classification of jumps, Characteristics of jumps in a rectangular channel, Use of the jump as an energy dissipater, Location of the jump.			10 Hours

Course outcomes: On completion of this course, students are able to

- Sketch the Pressure and Velocity distribution across various channel sections
- Able to determine critical depth and hydraulic exponents for flow through various channel sections.
- Able to estimate normal depth under uniform flow condition through different prismatic channels sections.
- Able to sketch the water surface profiles under gradually varied flow conditions.
- Estimate the energy dissipation in hydraulic jump.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books

1. K. Subramanya, Flow in Open Channels, TATA Mc GRAW HILL Publishing Company Limited, New Delhi.
2. Chaudhry, M.H., Open Channel Flow, Prentice-Hall, Englewood Cliffs, New Jersey, USA, 1993.
3. K.G. Ranga Raju, Flow through open channels, TATA Mc GRAW HILL Publishing Company Limited, New Delhi

Reference Books:

1. Chow, V.T., "Open Channel Hydraulics", Mc Graw-Hill, New York, USA, 1959.
2. Henderson, F.M., Open Channel Flow, Mcmillan, New York, 1966.
3. Rouse, H., Engineering Hydraulics, John Wiley, New York, 1950.
4. French, R.H., Open channel hydraulics, Mc Graw Hill Book Co., New York, 1985

GEOSPATIAL TECHNOLOGY LABORATORY [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20 WLM L26	IA Marks	40
Number of Teaching Hours/Week	00:04:00	Exam Marks	60
Credits	02	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To be able prepare and analysis of spatial data. To be able use hydrological simulation models. 			
Topics			Teaching Hours
GIS Application <ol style="list-style-type: none"> 1. Introduction to QGIS 2. Map registration/ Geo-referencing 3. Digitization 4. Map projection 5. ER Diagram 6. Design of Geo-database 7. Interpolation and Buffering 8. Image Classification-Supervised 9. Image Classification- UnSupervised 10. Watershed Delineation 11. Geophysical investigation 			42 Hours
Course outcomes: On completion of this laboratory studies students are able <ul style="list-style-type: none"> To Prepare and analysis the spatial data for management of water and land resources. To use simulation model to generate information on hydrological responses of the study area. 			
Conduction of Practical Examination: <ol style="list-style-type: none"> 1. All laboratory experiments must be included for practical examination. 2. Students are allowed to pick one experiment from each part and execute both. 3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks 4. Experiment 1: Procedure + Conduction + Viva: 08 + 14 +08 (30) Experiment 2: Procedure + Conduction + Viva: 08 + 14 +08 (30) 5. Change of experiment is allowed only once and Marks for the procedure for the alternate experiment is not given. 			

THIRD SEMESTER

ENVIRONMENTAL IMPACT ASSESSMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM31	IA Marks	40
Number of Teaching Hours/Week	03:00:02	Exam Marks	60
Credits	04	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To know about objectives and scope of EIA To understand various Methodologies/Techniques of EIA-checklist To Assess and Predict Impacts of ecological attributes To study various mitigation measures 			
Modules			Teaching Hours
Module -1 Introduction to EIA: Introduction to EIA, Development Activity and Ecological Factor, Need for EIA Studies, Step-by-step procedures for conducting EIA, EIS, FONSI, Limitations of EIA, Environmental Setting, Objectives and Scope, Contents of EIA, Transnational effects of projects, Problems of EIA in developing countries			10 Hours
Module -2 EIA Methodologies: , Methodologies/Techniques of EIA-checklist, matrix, network analysis, environmental index, overlay, simulation method and cost benefit analysis technique.			10 Hours
Module -3 Assessment and Prediction: Assessment and Prediction of Impacts of ecological attributes and mitigation measures - Air, Surface-Water, Noise, Soil and Groundwater, Biological Environment			10 Hours
Module -4 Assessment and Prediction Contd.: Assessment and Prediction of Impacts of ecological attributes and mitigation measures - Cultural and Socio-economic Environment, Rapid and Comprehensive EIA, EIA Regulations in India. Public Participation: Advantages, Limitations, Role of Public Participation in EIA			10 Hours
Module -5 Case Studies: EIA for Water resource developmental projects, Highway projects, Nuclear-Power plant projects, Mining project (Coal, Iron ore), Thermal power plant project, Pharmaceutical industries, Textile industries.			10 Hours
Course outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> know about objectives and scope of EIA 			

<ul style="list-style-type: none"> • understand various Methodologies/Techniques of EIA-checklist • Assess and Predict Impacts of ecological attributes • Implement various mitigation measures
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>
Text Books: <ol style="list-style-type: none"> 1. L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1996 2. Y. Anjaneyulu, ValliManickam. “Environmental Impact Assessment Methodologies”, CRC Press, 2011 Reference Books:- <ol style="list-style-type: none"> 1. Jain R.K. Urban L.V. and Stacey G.S. “Environmental Impact Analysis: A New Dimension in Decision Making”, 2nd Ed., Van Nostrand Reinhold Co. New York. 1981. 2. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005

WETLAND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20 WLM321	IA Marks	40
Number of Teaching Hours/Week	03	Exam Marks	60
Credits	03	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> • To understand history and definitions of Wetlands • To know about wetland classification and delineation • To have knowledge of major wetland indicators i.e. Hydrology, Hydric soil and Hydrophytes • To understand different techniques of wetland conservation, restoration and creation 			
Modules			Teaching Hours
Module -1 Introduction: History, definition of wetlands, Wetland indicators, Wetland Laws, National wetland inventory, Status and trends of wetlands, The Ramsar Convention.			08 Hours
Module -2 Wetland Classifications: Cowardin’s and Hydro geomorphologic wetland classification system. Types and Classification of wetlands (based on Source): Precipitation, surface water and groundwater. Wetland delineation- Technical guidelines, Characteristics and indicators, Methods-preliminary data gathering and synthesis, Selection of methods.			08 Hours

Module -3	
Wetland Indicators: Wetland Hydrology- Hydrologic cycle, Criteria and field indicators, Kinds of hydrological data,. Wetland recharge and discharge, wetland water budget and balance. Wetland Soils- Characteristics, Indicator guidelines, field indicators of Hydric soils, Test indicators of Hydric soils. Wetland vegetation/ hydrophytes: Characteristics, indicator guidelines, influencing factors, classification, Functions and values.	08 Hours
Module -4	
Wetland conservation and Development: Wetland ecosystems and its environmental significance, Factors affecting wetland habitats. Wetland management-Definition and classification, Wetland values and functions, Wetland degradation and loss, Conservation of wetlands, Wetland management principles. Identifying major problems and Setting objectives and priorities, Management of wetland habitats for ecological processes and wildlife.	08 Hours
Module -5	
Wetland Assessment and Monitoring: Natural and constructed wetlands, Managing wetlands for multifunctional benefits, the role of landscape architects in wetlands. Floating Islands-An Alternative to Urban Wetlands and case studies.	08 Hours
<p>Course outcomes: At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> • Explain a history of wetlands and define a Wetland • Delineate wetlands based on different classifications • Identify major wetland indicators i.e. Hydrology, Hydric soil and Hydrophytes • Apply different techniques for wetland conservation, restoration and creation 	
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
<p>Text Books:</p> <ol style="list-style-type: none"> 1. William J. Mitsch, James G. Gosselink, "Wetlands", Published by John Wiley and sons, Inc., Hoboken, New Jersey, Canada 2. Falconer, R. A and Goodwin, P (Ed), "Wetland Management", 1994, Thomas Telford, London. <p>References:</p> <ol style="list-style-type: none"> 1. Bruce E. Hammer., "Constructed Wetlands for Wastewater Treatment", 1989, CRC-Press; I Ed. 2. Verhoeven, J.T.A., Beltman, B., Bobbink, R., Whigham, D.F. (Eds.). "Wetlands and natural resource management", Springer-Verlag Berlin Heidelberg, 2006. 	

INDUSTRIAL SAFETY, HEALTH , AND ENVIRONMENTAL MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM322	IA Marks	40
Number of Teaching Hours/Week	03:00:00	Exam Marks	60
Credits	03	Exam Hours	03
Course objectives: The course is designed to train students: <ul style="list-style-type: none"> • To have through knowledge about occupational health, industrial hygiene, accidental prevention techniques • To make the student aware about safety auditing and management systems, pollution prevention techniques etc. • To Learn about risk assessment and management. • To identify risks, link to individual behaviors, evaluate precautions and preparations, identify correct processes and procedures, identify critical points, & also improve decision making. 			
Modules			Teaching Hours
Module -1 Occupational Safety and Health Management : Introduction: Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws. Indian Acts – Labour Act, Factories Act, OSHA Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Health and Safety Considerations, Personal Protective Equipment			08 Hours
Module -2 Radiation and Industrial Hazards			
Radiation -Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation Industrial noise -Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health Vibration - effects, measurement and control measures Industrial Hygiene.			08 Hours
Module -3 Electrical, Fire Hazards & safety			
Electrical Hazards Safe limits of amperages, voltages, distance from lines, etc., Joints and connections, Overload and Short circuit protection, Earthing standards and earth fault protection , Protection against voltage fluctuations, Effects of shock on human body Hazards from Borrowed neutrals, Electrical equipment in hazardous atmosphere, Criteria in their selection, installation, maintenance and use, Control of hazards due to static electricity, Fire and other Hazards General causes and classification of fire, Detection of fire, extinguishing methods, fire fighting installations with and without water. Machine guards and its types, automation. High pressure hazards, safety, emptying, inspecting, repairing, hydraulic and nondestructive testing.			08 Hours

Module -4 Ergonomics & Accident	
Ergonomics: Introduction, Definition, Objectives, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders need, Task Analysis, Preventing Ergonomic Hazards, Ergonomics Programme. Accident – Causation, investigation methods and different models	08 Hours
Module -5 Occupational Hazard and Control	
Hazard Analysis , Human Error and Fault Tree Analysis, Emergency Response. Hazards and their control in different manufacturing and processing industries. Importance of Industrial safety , role of safety department, Safety committee and Function. Health problems in different types of industries –Textile, steel and food processing, pharmaceutical, Tannery , Cement , Dairy , Paper and Pulp, canning industry. occupational Health and Safety considerations in Wastewater Treatment Plants.	08 Hours
Course outcomes: On completion of this course, students are able to <ul style="list-style-type: none"> • Contribute to the development and maintenance of a healthy and safe work environment • Interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces • Apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards • Collect, manage, and interpret information and data to identify trends and issues in the workplace • Design, support, and evaluate health and safety programs and implement procedures using project management principles and processes appropriate to the task • <input type="checkbox"/> Affect/manage change by advancing OH&S principles within management systems, cultures, practices, and priorities. 	
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 20 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books : <ol style="list-style-type: none"> 1. R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006) 2. Slote.L, Handbook of Occupational Safety and Health, John Willey and Sons, New York . Reference Books: <ol style="list-style-type: none"> 1. Goetsch D.L., “Occupational Safety and Health for Technologists”, Engineers and Managers”, Prentice Hall. 2. Heinrich H.W., “Industrial Accident Prevention”, McGraw Hill Publication , Newyork. 3. Colling D.A., “Industrial Safety Management and Technology”, Prentice Hall, New Jersey. 	

INDUSTRIAL WASTEWATER MANAGEMENT AND AUDIT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20 WLM323	IA Marks	40
Number of Teaching Hours/Week	03:00:00	Exam Marks	60
Credits	03	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To provide an understanding of the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use. To understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater. 			
Modules			Teaching Hours
Module -1 Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effects of waste additions on physical and chemical properties of soil. Effluent standards and receiving water quality standards. Different aspects and choices of various disposal alternatives.			08 Hours
Module -2 Industrial Waste survey- Step by Step Procedure of industrial survey, Process flow charts, condition of waste stream. Material balance, Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Bio- Monitoring. Sampling Procedure, Stages and Preservation.			08 Hours
Module -3 Pretreatment of Industrial Wastewater – Volume reduction, Strength reduction, Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids. Wastewater Treatment in specific industries: Sugar, Pulp and paper, Cement, Textile, Tannery, Dairy.			08 Hours
Module -4 Sources, Process, Characteristics and Treatment system & disposal for industries: Industries: Fertilizer, Tannery, Pulp, and Paper Mill, Dairy , Cane Sugar , Textile, Distillery and Brewery, Petrochemical industry wastewater. Radio Active Wastes treatment- Low activity and high activity radiation, application of radioactive techniques for wastewater treatment. Bio-Remediation of contaminated soils			08 Hours
Module -5 Environmental Auditing: Introduction, objectives, Role and necessity,			08 Hours

stages involved, Cost of Pollution, Importance of Environmental audit and solutions, Financial and Managerial opportunities.	
Course outcomes: After completion of course student will be able to: <ul style="list-style-type: none"> • Learn physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewater. • Understand the theory, engineering application, and design technique for the industrial wastewater treatment unit processes. 	
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>	
Text Books: <ol style="list-style-type: none"> 1. Eckenfelder, "Industrial Water pollution Control"- McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA 2. Nemerow N.N., "Liquid Waste of industry theories, Practices and Treatment". Addison Willey New York. 3. Mahajan," Pollution control in Process industries". TMH, New Delhi. Reference Books <ol style="list-style-type: none"> 1. Azad N. S., "Industrial Wastewater Management Hand Book" McGraw Hill book Co., New York. 2. Ross R.D. "Industrial Waste Disposal", Reinhold Environmental Series – New York. 3. Dickinson" Practical Waste Treatment and Disposal Applied Science publication, London. 	

GROUNDWATER ASSESSMENT, DEVELOPMENT AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM331	IA Marks	40
Number of Teaching Hours/Week	03:00:00	Exam Marks	60
Credits	03	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To understand groundwater flow To Evaluate aquifer properties To Understand groundwater development and management technique To apply mathematical model for assessment of groundwater 			
Modules			Teaching Hours
Module -1 Zones of Aeration and Saturation: Zone of aeration, Zone of saturation, Storage efficient of aquifers, Fluctuations of the water table, Fluctuations of the piezometric surface, Recharge and discharge areas. Ground Water Flow: Properties of water in relation to flow, Head distribution, Laminar and turbulent flow, Darcy's law. Formation constants, Flow through aquifers.			08 Hours
Module -2			
Evaluation of Aquifer Properties: Aquifer tests, Confined aquifers, Semiconfined aquifers, Unconfined and semiunconfined aquifers, Transition for artesian to water table conditions, Bounded aquifers, Partially penetrated aquifers, Sloping piezometric and phreatic surfaces, Areal methods. Sea Water Intrusion: Sea Water Intrusion in Coastal Aquifers, Modelling of Pollutant Transport in the Unsaturated Zone. Prevention and Control of Seawater Intrusion.			08 Hours
Module -3			
Ground Water Recharge, Discharge and Balance: Parameters of Ground-Water Balance, Estimation of Recharge Components, Nuclear Methods, Estimation of Ground Water Discharge, Ground Water Resources Evaluation In India, Case History.			08 Hours
Module -4			
Ground Water Development and Management: Ground-Water Development, Water logging, Conjunctive use, Desalination, Modelling Techniques in Ground-Water Management, Ground Water Legislation. Management of Groundwater: Pollution in Relation to water use, Municipal sources and causes, Industrial sources and causes, Agricultural sources and			08 Hours

causes, Miscellaneous sources And causes, Attenuation of Pollution, Monitoring Groundwater Quality	
Module -5	
Groundwater Basin Management and Conjunctive Use: Groundwater Basin Management, Conjunctive Use, Mathematical modelling of a dual aquifer system.	08 Hours
Course outcomes: On completion of this course, students are able to <ul style="list-style-type: none"> Assess the different aquifer properties Apply mathematical model for assessing groundwater Evaluate and apply groundwater management techniques 	
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question consists of 16 marks. There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module. The students will have to answer 5 full questions, selecting one full question from each module.	
Text Books: 1. K. R. Karanth, Ground Water Assessment Development and Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.1.	
Reference Books: 1. David Keith Todd, Groundwater Hydrology, Gopsons Paper Ltd., Noida, Second Edition. 2. H. M. Raghunath, Ground Water, New Age International (P) Ltd., New Delhi, Third Edition.	

WATER MANAGEMENT: CONSERVATION, HARVESTING AND ARTIFICIAL RECHARGE [As per Choice Based Credit System (CBCS) scheme]			
Subject Code	20WLM332	IA Marks	40
Number of Teaching Hours/Week	03:00:00	Exam Marks	60
Credits	03	Exam Hours	03
Course objectives: <ul style="list-style-type: none"> To understand various kinds of water losses and their methods of estimation To know different kinds of conservation measures.. To understand various methods of water harvesting technologies. To study methods of artificial recharges. 			
Modules			Teaching Hours
Module -1			
Water Management: Overview, Floods and Droughts, Water Quality Management, Fresh Water Management, Wastewater Management, Recycling and Reuse of Water, Water Conservation, Need of Ensuring Quality and Cost Effectiveness of Water Harvesting. Hydrologic Cycle: Introduction, Atmospheric Water, Precipitation, Surface Water, Infiltration, Groundwater, Evapo-transpiration, Recharge. Ground Water Occurrence: Introduction, Groundwater Occurrence, Sources of Groundwater, Factors Controlling Groundwater, Water Bearing Properties of Soil and Rocks. Types of Aquifers, Aquifers lithology, Groundwater Flow, Groundwater Exploration, Aquifer Performance Test.			10 Hours
Module -2			
Water Losses: Introduction, Evaporation, Transpiration, Interception, Depression Storage, Infiltration Water Conservation: Introduction, Development of New Supplies, Reducing Demand of Water, Evaporation Control, Equipments, Studies of Evaporation Control, Conservation of Soil Moisture, Soil Mulches, Influence of Farmyard Manure on Soil Moisture.			10 Hours
Module -3			
Rain Water Harvesting: Introduction, Rain Water Harvesting, Roof Water Harvesting, Water Harvesting by Ponds, Water Quality Consideration.			10 Hours
Module -4			
Artificial Recharge Methods: Introduction, Natural Recharge Measurements in India, Concepts of Artificial Recharge, Methods of Artificial Recharge, Theory of Artificial Recharge by Spreading, Check Dam, Percolation Tank, Classification of Tanks, Flooding Methods, Indirect Methods.			10 Hours
Module -5			
Methods of Artificial Recharge Practiced by People in Drought Prone Area, Well Clogging Mechanism and their Prevention, Cleaning of Injection Wells.			10 Hours

Course outcomes: On completion of this course, students are able to

- Estimate the various kinds of water losses
- Apply appropriate water conservation methods.
- Use most suitable water harvesting technology for the area.
- Adopt most suitable artificial recharge method for the situation.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books

1. Patel, A.S. and Shah, D.L., (2017) Water Management, New Age International, New Delhi
2. Patel, A.S. et al., (2003) Manual of Water Harvesting, GSFC Science Foundation, Vadodara, India.
3. Huisman, L. And Olsthoorn, T.N. (1983) Artificial Groundwater Recharge, Pitman Advanced Publishing Program, Boston.

Reference Books:

1. Hillel, I.S., (1977) Water Renovation and Reuse, Academic Press, New York.
 2. Jawad, A.S. and Akashi, A. (2000) Wastewater Reclamation and Reuse, New Age International Pvt Ltd., New Delhi.
- UNDP (1998, 2001), State of the environment, India, United Nation Environmental Program.

GLOBAL WARMING AND CLIMATE CHANGE

[As per Choice Based Credit System (CBCS) scheme]

Subject Code	20WLM333	IA Marks	20
Number of Teaching Hours/Week	03	Exam Marks	80
Credits	03	Exam Hours	03
Course objectives: To provide an understanding of: <ul style="list-style-type: none"> • The factors responsible for climate change • The biological and sociological consequences of such changes; and • The possible engineering, economic, and legal solutions to avoid more extreme perturbations. 			
Modules			Teaching Hours
Module -1			
Introduction: Introduction and history of meteorology and climatology: The atmosphere, Solar energy, Global circulation, Climatology, Mid-latitude disturbances, The polar regions, Tropical weather, Paleoclimates, The global climate system Atmospheric composition, mass and structure Composition of the atmosphere: Primary gases, Greenhouse gases, Reactive gas species, Aerosols, Variations with height, Variations with latitude and			08 Hours

season, Variations with time	
Mass of the atmosphere: Total pressure, Vapor pressure	
Module -2	
Atmospheric composition, mass and structure The layering of the atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere and magnetosphere Solar radiation and the global energy budget : Solar radiation : Solar output, Terrestrial infrared radiation and the greenhouse effect, Heat budget of the earth Atmospheric moisture budget : The global hydrological cycle, Humidity, Evaporation, Condensation, Precipitation characteristics and measurement	08 Hours
Module -3	
Numerical models of the general circulation, climate and weather prediction Fundamentals of the GCM, Model simulations: GCMs, Simpler models, Regional models, Data sources for forecasting, Numerical weather prediction: Short- and medium- range forecasting, Nowcasting, Long-range outlooks.	08 Hours
Module -4	
Boundary layer climates Surface energy budgets, Non-vegetated natural surfaces : Rock and sand, Water, Snow and ice Vegetated surfaces: Short green crops, Forests Urban surfaces: Modification of atmospheric composition, Modification of the heat budget, Modification of surface characteristics, Tropical urban climates.	08 Hours
Module -5	
Climate change: General considerations, Climate forcing, feedback and response : Climate forcing, Climate feedbacks, Climate response, The importance of framework The climatic record : The geological record, The last glacial cycle and post-glacial conditions, The past 1000 years Understanding recent climatic change : Circulation changes, Solar variability, Volcanic activity, Anthropogenic factors Projections of temperature change through the twenty-first century : Applications of General Circulation Models, The IPCC simulations Projected change in other system components : Hydrologic cycle and atmospheric circulation, Global sea level, Snow and ice, Vegetation, Postscript	08 Hours
Course outcomes: On completion of this course, students are able to:	

<ul style="list-style-type: none"> • Measure climate factors and how they change • Understand connections between global warming and human activities • Identify effects of climate change on biodiversity and ecosystems in different biomes and aquatic systems • Model possible scenarios for future climate change • Achieve possible ways to deal with climate change.
<p>Question paper pattern:</p> <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question consists of 16 marks. • There will be 2 full questions (with a maximum of four sub questions) from each module. • Each full question will have sub questions covering all the topics under a module. <p>The students will have to answer 5 full questions, selecting one full question from each module.</p>
<p>Text Books:</p> <ol style="list-style-type: none"> 1. Barry R.G., and Chorley R.L., “Atmosphere, Weather and Climate”, 4th Edition, ELBS Publication. 2. Bolin B., (Ed.), “Carbon Cycle Modelling”, John Wiley and Sons Publications. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Srivatsava A.K., “Global Warming”, APH Publications. 2. Wyman R.L., (Ed.), , “Global Climate Change and Life on Earth”, Chapman and Hall Publications. 3. Yadav, Chander and Bhan, “Global Warming: India’s Response and Strategy”, RPH Publications.

ENVIRONMENTAL PLANNING AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Subject Code		IA Marks	40
Number of Teaching Hours/Week	03:00:00	Exam Marks	60
Credits	03	Exam Hours	03
Course objectives: <ul style="list-style-type: none">• This course will enable students to • Understand the management and to apply the skills of the management when they become an entrepreneur			
Modules			Teaching Hours
Module -1			08 Hours
Management Introduction – Meaning – nature and characteristics of Management, Scope and functional areas of management– Management as a science, art or profession – Management & Administration – Roles of Management, Levels of Management, Development of Management Thought – early management approaches – Modern management approaches Planning Nature, importance and purpose of planning process – objectives – Types of plans (Meaning only) – Decision making – Importance of planning – steps in planning & planning premises – Hierarchy of plans.			

Module -2	
Organizing and Staffing Nature and purpose of organization – principles of organization – Types of organization – Departmentation – Committees – Centralization Vs Decentralization of authority and responsibility – Span of control – MBO and MBE (Meaning only) Nature and importance of Staffing – Process of Selection & Recruitment (in brief). Directing & Controlling - Meaning and nature of directing – Leadership styles, Motivation Theories, Communication – Meaning and importance – Coordination, meaning and importance and Techniques of Coordination. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).	08 Hours
Module -3	
Entrepreneurship Meaning of Entrepreneur, Evolution of Concept, Functions of Entrepreneur, Types of Entrepreneur, Entrepreneur – an emerging class. Concept of Entrepreneurship – Evolution of Entrepreneurship, Development of Entrepreneurship, Stages in entrepreneurial process, Role of Entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.	08 Hours
Module -4	
Small Scale Industry Definition; Characteristics; Need and rationale : Objectives, Scope, role of SSI in Economic Development. Advantages of SSI. Steps to start an SSI – Government policy towards SSI, Different Policies of SSI., Government Support on SSI., during 5 year plans. Impact of Liberalization, Privatisation, Globalization on SSI. Effect of WTO / GATT Supporting Agencies of Government for SSI Meaning. Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only).	08 Hours
Module -5	
Preparation of Project, Meaning of Project, Project Identification, Project Selection, Project Report, Need and significance of Project, Contents, formulation, Guidelines by Planning Commission for Project Report, Network Analysis, Errors of Project Report, Project Appraisal. Identification of Business Opportunities. Market Feasibility Study : Technical Feasibility Study, Financial Feasibility Study & Social Feasibility Study	08 Hours
Course outcomes: On completion of this course, students are able to <ul style="list-style-type: none"> Identify, select a suitable Project Write a Project Report, with formulation and understand the Guidelines by Planning Commission for Project Report. Become a Entrepreneur 	

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Management – P.C. Tripathi, P.N. Reddy, Tata McGraw Hill,
2. Dynamics of Entrepreneurial Development & Management – Vasant Desai, Himalaya Publishing House. • Entrepreneurship Development – Small Business
3. 3. Enterprises – Poornima M. Charantimath – Pearson Education – 2006 (2&4).

Reference Books:

- Management Fundamentals – Concepts, Application, Skill Development – Robert Lusier – Thomson .
- Entrepreneurship Development – SS Khanka – S Chand & Co.
- Management – Stephen Robbins – Pearson Education / PHI – 17th Edition, 2003.