VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Department of Civil Engineering
"Jnana Sangama", Belagavi - 590 018

PROGRAM: WATER AND LAND MANAGEMENT (ULM)

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

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 environmentalneeds
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 minimizeimpacts
PO7	Work and lead in multi disciplinary environment and demonstrate professional andsocial ethics
PO8	Engage in critical thinking and pursue lifelong learning for professionaladvancement

Semester- I

OPTIMIZATION TECHNIQUES FOR NATURAL RESOURCES [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22WLM11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the development and applications of optimization concepts
- To formulate Linear and dynamic programming for obtaining solution for real world problems
- To find optimized solutions for transportation and assignment problems
- To learn simulation techniques and understand the Network analysis concept for optimizing the project management works

Module-1	
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.	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments
Module-2	
Introduction to Linear programming, problem formulation, graphical solution, solution by simplex method, Big M and Two Phase method.	
Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments
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.	
Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments
Module-4	
Basic principles and concepts - Random variant and random process – Monte Carlo techniques - Model development - Inputs and outputs - Case studies.	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments
Module-5	
Dynamic programming- Introduction, Approaches, Application and case studies, Network analysis-CPM & PERT	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Flipped classroom, Assignments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or one Skill Development Activity of **40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to **50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. S.D. Sharma: ―Operations Research, KedaranathRamnath& Co. Meerut.
2. Rao,S.S. ―Engineering Optimizatio, John Wiley & Sons,1996.
3. KantiSwarup, P.K. Gupta &Manmohan ―Operations Research, Sultan Chand & Sons, 2014.

Reference book

1. H.A. Taha: ―Operations Research, Macmilan 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.

Web links and Video Lectures (e-Resources):

- NPTEL Materials: https://nptel.ac.in/courses/111105039
- Google Books: https://www.google.co.in/books/edition/Optimization_Techniques_in_Operation_Res/JL5EFfKVoBcC?hl=en&gbpv=1&dq=optimization+techniques+india&printsec=frontcover
- YouTube Lectures: https://www.youtube.com/watch?v=84HOL_EiJ4M&list=PLLtQL9wSL16ioUvHckGCkoWq_CIvyUI0p

Skill Development Activities Suggested

- Flipped classroom activity
- Group works
- Solving Numerical
- Case study analysis

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Explain history & development of optimization concepts	L2
2.	Formulate Linear and dynamic programming for real world problems	L3, L4, L5
3.	Apply different optimization techniques available for obtaining solution for real world problems	L3, L4, L5
4.	Find optimized solutions for transportation and assignment problems	L3, L4, L5
5.	Apply optimization techniques for solving present problems related to water and land management	L3, L4, L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1								X
CO2				X	X	X	X	
CO3	X	X			X	X	X	
CO4					X	X	X	
CO5	X		X		X		X	

Semester - 1

REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 12	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

Students will be able to know

- To understand basic concept & techniques of Remote Sensing and GIS.
- To acquire skills in image processing techniques and interpretation of remotely sensed data.
- To develop spatial database for its various application.
- To perform various spatial analysis related to water and land management.

MODULE-1

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.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Assignments

MODULE-2

Visual Image Interpretation: Introduction

Digital Image Processing: Introduction, Basic Character of Digital Image, Pre-processing: 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.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Skill enhancement through problem solving. Image enhancement techniques using open source software.

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.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, map making techniques using open sources GIS software.

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.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Performing spatial analysis techniques using open sources GIS software.

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.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Skill enhancement through problem solving. Understanding spatial analysis techniques using open sources GIS software.

PRACTICAL COMPONENT OF IPCC

Sl. No.	Experiments
1	Familiarization with Maps of different scales (SOI Toposheets).
2	Familiarization with Monochromatic and Multispectral Satellite Imagery (Creation of FCC).
3	Ground truth collection and geotagging of sample sites using any hand-held GPS or a Mobile App.
4	Visual Interpretation of Aerial photographs & Satellite Imagery and area measurement.
5	Atmospheric & Radiometric Correction of Satellite Images.
6	Import and Export of Satellite data to various formats using different software.
7	Development of Spatial Geodatabase.
8	Spatial Data creation using field data in GIS Software environment.
9	Feature extraction (Vectorization) using GIS Software.
10	Familiarization in open source like (Q- GIS).
11	Generating the spectral reflectance of land covers using a spectroradiometer or a Hyperspectral satellite RS Data.
12	Introduction to practical using Google Earth Engine

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However,

in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Text Books:

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:

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.

Web links and Video Lectures (e-Resources):

- Students are encouraged to visit SWAYAM web site where there are several Massive Open Online Courses (MOOC), http://swayam.gov.in
- ISRO-IIRS outreach programme and conducting live & Interactive courses at our Institute/Organization

Skill Development Activities Suggested

- Flipped classroom activity
- Case study analysis
- Group discussion / work

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Develop a sound understanding of the Basic principles and function techniques of Remote Sensing & GIS.	L1, L2
2.	Understand various techniques in preparing spatial data.	L1, L3
3.	Designing & Manipulation of spatial database.	L4, L6
4.	Acquiring knowledge of Spatial Data Analysis and Visualization	L4, L5
5.	Image Interpretation, Digital Image Processing, Remote Sensing Technologies	L2, L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X		X			X		
CO2		X	X				X	
CO3			X	X	X			
CO4			X			X	X	X
CO5	X	X	X		X	X		

Semester- 1

SURFACE WATER HYDROLOGY			
Course Code	22 WLM 13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:02	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching + 10- 12 sessions of SDA	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- 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

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

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 BlaneyCriddle formula.

Infiltration-Process, Factor affecting infiltration, Measurement, Horton's equation and Philip's equation. Infiltration indices.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3

Runoff:-Process, Factors affecting runoff, API, Basin yield, Curve number method, water budgeting. Correlation, Regression analysis-Simple linear and Multiple linear regressions, Curvilinear regression.

Classification of models, Model formulation, Lumped parameter conceptual models, Physically based models, Model performance testing.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Understanding hydrological models through literature review

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

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, NPTEL course, Understanding the use of UH theory for various applications through literature study

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, NPTEL course, Understanding various applications of floor routing through literature study

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

TextBooks

1. SubramanyaK."Engineering Hydrology", Tata McGraw Hill, 1998
2. Jaya Rami Reddy, P. "A text book of Hydrology", Laxmi publications,2009
3. Putty, M. R.Y. "Principles of Hydrology", I.K. Int. Publishing House, New Delhi,2010

Reference Books:

1. Linsley R K, Kohler and Paulhus. "Hydrology for Engineers", McGraw Hill, NY, USA,1958.
2. Mutreja, K. N. "Applied hydrology", Tata McGraw Hill Pub. Co., New Delhi, India-1986.

3. Chow, V.T. "Handbook of Applied hydrology", McGraw Hill, NY, 1964

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105214/
- https://www.aboutcivil.org/new/hydrology.html
- https://web.iitd.ac.in/~dhanya/Engineering_Hydrology.html

Skill Development Activities Suggested

- Knowing various applications of floor routing through literature study and applying the same to real time problems.
- Study of different available hydrological models through literature review and using them on possible catchment.
- Understanding the applications UH theory for various purposes and to derive UH for the catchment.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Analyze components of hydrologic cycle	L1,L2
2.	Predict hydrologic extreme events for hydraulic and hydrologic design	L2,L3,L5
3.	Develop forecasting models for operation of hydrologic systems	L2,L4,L5,L6
4.	Assess surface water resources	L4,L5,L6

Mapping of COS and POs

	PO1	PO2	PO6	PO7	PO8
CO1	×	×	×		
CO2	×	×	×	×	×
CO3	×	×	×	×	×
CO4	×	×	×	×	×

Semester- 1

HYDRAULIC STRUCTURES [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching + 10- 12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To learn factors governing site selection for construction of different hydraulic structures and to different kinds of failures of hydraulic structures;
- 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.

Module-1	
Gravity Dam: Factors governing selection of type of dam, Forces acting on gravity dam section, Principle and shear stresses, Modes of failures, stability analysis, high/low gravity dam, elementary/ practical profile, Gravity and Zonal method of design.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Analysing the section of a dam for its stability.
Module-2	
Earthen Dam: Types, Causes of failure, General principles of design, Analysis of seepage through earth dams, Stability analysis, Control of seepage.	
Teaching-Learning Process	Black board, LCD, Knowing failures of dams through literature, Skill enhancement through design and stability check evaluation.
Module-3	
Spillway: Types, Design criteria (Ogee), Energy dissipaters **Diversion Structures:** Types, Causes of failure and their remedial measures, Bligh's Theory and Khosla's Theory.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through the designing Ogee section of gravity dam and associated energy dissipaters, Knowing failures of diversion structures through literature study.
Module-4	
Design of Vertical Drop Weir: Design of floor length and thickness for weir, Design of weir on permeable foundation **Regulators**: Functions of cross and head regulator, Alignment types, Design of Cross Regulators and Head regulators.	
Teaching-Learning Process	Black board, LCD, Design of weirs on permeable soils. Study of regulator structure across canals, Skill enhancement through the design of canal regulators
Module-5	
Canal System: Canal networks, Design of unlined channels, Kennedy's and Lacey's theory of canal design, Types of Canal falls and Canal Escapes.	
Teaching-Learning Process	Black board, LCD, Skill enhancement by doing design of canals.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. 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.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105110/
- https://www.vssut.ac.in/lecture_notes/lecture1424715569.pdf
- https://nptel.ac.in/courses/10510511

Skill Development Activities Suggested

- Solving problem and checking stability of dam section.
- Design of Ogee section of gravity dam and associated energy dissipaters
- Design of various components of canal regulators
- Design of canals by different methods.
- Design and stability check evaluation for weir on permeable soils.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Select site for construction of hydraulic structures	L1, L2,L3,L4
2.	Identify the reasons for failures of hydraulic structures	L3,L4,L5
3.	Estimate forces on hydraulic structures for design	L2,L3,L4,L5
4.	Design different hydraulic structures like dam, regulator, and canal.	L4,L5,L6

Mapping of COs and POs

	PO1	PO3	PO4	PO5	PO6	PO7	PO8
CO1	×	×	×	×			×
CO2	×	×	×		×	×	×
CO3	×	×	×	×	×	×	×
CO4	×	×	×	×	×	×	×

Semester-1

WATER POLLUTION AND MANAGEMENT PRACTICES [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching + 10- 12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To know various methods and advanced techniques used in water pollution control, treatment and management.
- To understand the domestic and industrial waste effect on the environment.
- To understand the water and waste water sampling and monitoring methods and techniques.
- To study the important industries and its sources of wastewater, characterization, process and treatment.
- To study the concept of water quality modelling approaches and wastewater monitoring planning and management.
- To know the various recent trends, technique used for the water pollution control, treatment and management.
- To know various sustainable approaches for water and wastewater pollution control, treatment and management.
- Underrated Water Acts, laws, legislation.

Module-1

Introduction: Definition of Water Pollution, Cause and Sources, and Consequences of Water Pollution and Remedial Measures. Wastewater characteristics, Nature of pollutants, Ground water pollution –Cause, Sources and its effects on environment and Remedial Measures.

Industrial Waste Effects: On Sewage Treatment Plant and Receiving Water Bodies, Present Scenario of River and Lake Pollution in India. Self Purification of Streams. Effluent Standards and Stream Standards.

Field Visits: Water And Waste Water Treatment Plant.
(To Understand The Process And Treatment Of Waste Water)

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study. Field Visits.

Module-2

Wastewater Sampling -: Existing approaches of control/abatement of water quality degradation, Concept of Material Balance-Methods, wastewater Sampling methods and techniques, Sampling Procedure, Stages and Preservation. Natural methods of wastewater Disposal.

Water and wastewater Monitoring: Definition and concept of river and lake water quality monitoring and management. Water quality assessment of lake and river water, Wastewater Monitoring in stream, river and lake. Types and Methods of wastewater Monitoring, water and wastewater monitoring system in treatment plants, Stages Involved in Monitoring process, Equipment's used in Monitoring Process. Concept of Bio-monitoring. DO and BOD in streams, Transformation and transport processes, Oxygen Transfer, Turbulent mixing, Flow Augmentation.

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, online sources.

Module-3	
Point and Non-Point Source of Pollution: Point & Non – Point source pollution, NPDES Storm water program, Nutrient pollution. National Estuary Program (NEP), Water Quality Standards, Storm water Pollution, Green Storm water Management. Polluted Runoff. **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.	
Teaching-Learning Process	Black board, LCD, Literature study.
Module-4	
Water Acts, laws, legislation- importance of 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, EPA , NPDES, TSCA, RCRA, drinking water and wastewater resilience. **Sustainable water and wastewater management:** Sustainable approaches for water treatment and wastewater control, treatment and management, Sustainable water infrastructure. Sustainable rural wastewater management.	
Teaching-Learning Process	Black board, LCD, NPTEL Courses,
Module-5	
Industrial Wastewater Pollutants: Sources, Process, Characterization, Treatment of Wastewater And Effects of Industrial Effluents on Environment**.** Industries: Fertilizer, Tannery, Pulp, and Paper Mill, Dairy, Cane Sugar, Textile, Distillery and Brewery. **Field Visits**: Local Industries. (To Understand The Process And Treatment Of Waste Water)	
Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, online sources. Field Visits

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. H.S. Peavy, D.R. Rowe, G. Tchobanoglous. "Environmental Engineering", McgrowHill International Edition, 1st Edition, 2020.
2. Dr. B.C. Punmia, Arun Kumar Jain, Ashok Kumar Jain. Environmental Engineering, II, Laxmi Publications Pvt Limited, 2022
3. Dr. B.C. Punmia, Arun Kumar Jain, Ashok Kumar Jain, Wastewater Engineering, Laxmi Publications Pvt Limited, 2020.
4. Marcello Benedini, George Tsakiris, "Water Quality Modelling for Rivers and Streams", 2013.

Reference Books:

1. Environmental Protection Agency (EPA) guidelines, regulations, manual.
2. Steven C. Chapra, "Surface Water-Quality Modeling,"· 2008
3. Satinder Ahuja · "Monitoring Water Quality: Pollution Assessment, Analysis, and Remediation", Publisher:Elsevier Science, 2013
4. Daoliang Li, Shuangyin Liu , "Water Quality Monitoring and Management, Basis, Technology and Case Studies" · 2018
5. P.K. Goel , "Water Pollution Causes, Effects and Control", · publisher:New Age International 2006

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/102/105102159/

Skill Development Activities Suggested

- Skill enhancement through problem solving, field visit.
- Skill enhancement through online sources.
- Skill enhancement through attending NPTEL courses.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Adopt suitable methods and advanced techniques used in water pollution control, treatment and management.	L1, L2,L3,L4
2.	Implementation of preventive measures for the domestic and industrial waste effect on the environment.	L3,L4,L5
3.	Adopt suitable water and waste, water sampling and monitoring methods and techniques in to the practice	L2,L3,L4,L5
4.	Implement management practices for the sources of wastewater, characterization, process and treatment.	L4,L5,L6
5.	Apply the water quality modelling approaches in to the practice and adopt wastewater monitoring planning and management.	L3, L4,L5
6.	Adopt suitable recent trends, technique used for the water pollution control, treatment and management in to the practice.	L4,L5,L6
7.	Adopt various sustainable approaches for water and wastewater pollution control, treatment and management in to the practice.	L4,L5,L6

Mapping of COs and POs

	PO2	PO3	PO5	PO6	PO7
CO1	X	X	X	X	X
CO2	X			X	X
CO3	X		X	X	X
CO4	X	X	X	X	
CO5	X	X	X	X	X
CO6	X	X	X	X	
CO7	X	X	X	X	X

Semester-1

RESEARCH METHODOLOGY AND IPR [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the concept and objectives of research methodology.
- To gain the knowledge on literature review and research design.
- To understand the design of sampling, measurement and scaling.
- Understand the steps involved in the testing of hypothesis and Chi-square test.
- Gain the knowledge on interpretation and report writing and intellectual property rights.

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.

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study. Field Visits.

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, Basic Principles of Experimental Designs, Important Experimental Designs.

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, online sources.

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.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Teaching-Learning Process	Black board, LCD, Literature study.

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.

Teaching-Learning Process	Black board, LCD, NPTEL Courses,

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) Act1999, 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.

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, online sources. Field Visits

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

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.

Web links and Video Lectures (e-Resources):

- NPTEL Materials: https://nptel.ac.in/courses

Skill Development Activities Suggested

- Literature review
- Case study analysis

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Discuss research methodology and the technique of defining a research problem	L1,L2,
2.	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	L1,L2,L3
3.	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L1,L2,L3,L4, L5
4.	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	L1,L2,L4,L5
5.	Discuss various forms of the intellectual property its relevance and business impact in the changing global business environment and leading international Instruments concerning IPR.	L1,L2,L3

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X	X	X	X				
CO2	X	X	X	X	X	X	X	
CO3	X	X	X			X		
CO4	X	X		X		X		
CO5			X		X			X

Semester-1

HYDRO-SOIL ENGINEERING LABORATORY [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM L17	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	01:02:00	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

1. To Analysis the hydraulic properties of the soil.
2. To Measure and quantify flow and sediment yield in open streams.
3. To Analysis the sub-surface formation.
4. To Analysis the properties of plastic material using in micro-irrigation.

Sl. No.	Experiments
1	Determination of infiltration rate using Double ring infiltrometer.
2	Determination of flow in open stream.
3	Determination of sediment yield of the watershed.
4	Determination of ET using actual weather data and comparison with atmometer.
5	Determination of sub-surface formation using electrical resistivity method.
6	Measurement of Mean Emission Rate of Emitting tube
7	Determination of Tensile Strength & Elongation of Lateral
8	Determination of Melt Flow Index
Demonstration Experiments (For CIE) if any	
9	Carbon Black Dispersion test. & Carbon black content test-
10	Resistance of emitting tube to hydrostatic pressure at ambient/ elevated temperature
11	Reversion Test
12	Resistance to Pull outs of Joints between fitting and emitting tube.

Course outcomes (Course Skill Set):

On completion of this laboratory studies students are able to:

1. Analysis the hydraulic properties of the soil.
2. Measure and quantify flow and sediment yield in open streams.
3. Analysis the sub-surface formation.
4. Analysis the properties of plastic material using in micro-irrigation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination (SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
  - Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hour.

Suggested Learning Resources:

- Students are encouraged to visit SWAYAM web site where there are several Massive Open Online Courses (MOOC), http://swayam.gov.in
- Students are encouraged to take the benefits of SWAYAM PRABHA- the direct to home (DTH) 34 channels telecasting educational programmes on 24x7 basis using GSAT -15 satellite. The channels are up-linked from BISAG-N, Gandhinagar.

Semester-2

WATERSHED MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching + 10- 12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand causes and extent of soil erosion
- To study various possible soil conservation measures on a watershed
- To know various water harvesting and groundwater recharge measures
- To understand the watershed characteristics

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Determining morphometric parameters to some watershed.

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Understanding various sediment estimation models through literature review

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 levelling and grading, grassed waterways.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, Understanding land capability classification. Identifying suitable soil conservation practices for a certain land.

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-stream storage, Developing ground water- Recharge and Extraction, Water harvesting for trees and shrubs.
Agronomical measures in soil and water conservation: Land use and Conservation agronomy, Grassland Management, Agro-forestry, Horticulture.
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

Teaching-Learning Process	Black board, LCD, Skill enhancement through identifying suitable harvesting and conservation methods suitable for a ceratin land. Design of harvesting and conservation structures. NPTEL

Module-5

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through case studies. NPTEL

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

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

Suggested Learning Resources:

Text Books:

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.

Reference Books:

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.

Web links and Video Lectures (e-Resources):

- **https://archive.nptel.ac.in/courses/105/101/105101010/**
- **https://bbsbec.edu.in/wp-content/uploads/2020/01/watershed-management-8AG-PPT.pdf**
- **https://cfpub.epa.gov/watertrain/pdf/modules/watershed_management.pdf**

Skill Development Activities Suggested

- Delineation of watershed boundary for a chosen watershed.
- Identifying the soil properties on the field
- Identification of land capability class in the field using rating table
- Determining land capability symbol for a particular land.
- Identification of soil conservation practice on the land and precautions to be taken.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Identify causes of soil erosion	L2,L3,L4,L5
2.	Plan and design soil conservation measures in a watershed	L1,L2,L3,L6
3.	Plan and design water harvesting and groundwater recharge structures	L1,L2,L3,L6
4.	Can be able to identify suitable watershed practices based on objectives.	L2,L4,L5,L6

Mapping of COS and POs

	PO1	PO4	PO5	PO6	PO7	PO8
1.	-	×	×	×	-	-
2.	×	×	×	×	×	×
3.	×	×	-	×	×	×
4.	×	×	-	-	-	-

Semester-2

INDUSTRIAL WASTE WATER MANAGEMENT AND AUDIT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 22	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching + 10-12 slots of practical	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- 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.
- To study the effect of industrial waste water on the environment.
- To study the Effluent standards and receiving water quality standards and Industrial Waste survey.
- To study the Pre-treatment of Industrial Wastewater
- To study the Sources, Process, Characteristics and Treatment system & disposal for industries.
- To study the Radio Active Wastes, its treatment and its Disposal methods.
- To study the Environmental Auditing.

Module-1

Introduction : Characteristics of industrial waste water, pollutants in industrial wastewater and their effects, toxic pollutants in industrial wastewater, physical -chemical – biological properties of industrial wastewater. Type of industries and their effect on the environment. Sources of industrial wastewater, Treatment and disposal problem of industrial wastewater. Different aspects and choices of various disposal alternatives of industrial wastewater. Method of treatment.

Teaching-Learning Process	Black-Board Teaching, Solving numerical, Group work and Assignments

Module-2

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. Bio-Remediation of contaminated soils **Effluent standards and receiving water quality standards**.

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving

Module-3

Pre-treatment of Industrial Wastewater: Volume reduction, Strength reduction. Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, literature review

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, Cement.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, NPTEL course, through literature study

Module-5	
Radio Active Wastes, its treatment and its Disposal - Sources, Characteristics of Radio Active Wastewater, Low activity and high activity radiation, application of radioactive techniques for wastewater treatment. Radio Active Wastes management and disposal problem. **Environmental Auditing**: Introduction, objectives, Role and necessity, stages involved Flow chart of Environmental auditing, Cost of Pollution, Importance of Environmental audit and solutions, Financial and Managerial opportunities.	
Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving, NPTEL course, Understanding various applications through literature study

PRACTICAL COMPONENT OF IPCC:

Sl. NO.	Experiments
1	To understand the sampling procedure, steps and preservation of samples and carryout the sampling of water and wastewater.
2	To determine the physical properties of water and wastewater sample.
3	To determine the chemical properties of water and wastewater sample.
4	To determine the biological properties of water and wastewater sample.
5	Estimation of total solids, dissolved solids, suspended solids, volatile solids and fixed solids of given sample.
6	To determine the permanent and temporary hardness of water sample.
7	1. Estimation of residual and available chlorine in water sample. 2. Determination of available chlorine in bleaching powder.
8	Determination of BOD, COD and DO of given water sample.
9	Determination of chloride, fluoride and iron.
10	Local industrial (sewage treatment plant / effluent treatment plant) visit and preparation of the report.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum

Suggested Learning Resources:

TextBooks

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

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.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/course.html.
- https://archive.nptel.ac.in/courses/105/105/105105178/
- https://archive.nptel.ac.in/courses/105/107/105107207/
- https://archive.nptel.ac.in/courses/105/105/105105048/

Skill Development Activities Suggested

- Knowing various applications of floor routing through literature study and applying the same to real time problems.
- Study of different available hydrological models through literature review and using them on possible catchment.
- Understanding the applications UH theory for various purposes and to derive UH for the catchment.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Learn physical/chemical/biological characteristics of and the evaluation technique for various industrial wastewaters.	L1,L2, L3
2.	Understand the theory, engineering application, and design technique for the industrial wastewater treatment unit processes.	L1,L2,L3,L4, L5, L6
3.	Give preventive measures to reduce industrial waste water on the environment.	L1,L2, L3,
4.	Provide solution for Radio Active Wastes, its treatment and its Disposal. Carryout the Environmental Auditing.	L1,L2, L3

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		X			X			
CO2		X	X	X	X	X	X	
CO3			X		X	X	X	
CO4		X	X	X	X	X	X	X

Semester- 2

GROUND WATER HYDROLOGY [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand Governing equation of Groundwater flow in Aquifer.
- To know the models for Ground Water Analysis.
- To Analysis Steady State Well Hydraulics.
- To Study Artificial Recharge of Aquifers.

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving.

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving.

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving.

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 Laterally Stratified Phreatic Aquifers. Problems on well Hydraulics.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving.

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.

Teaching-Learning Process	Black board, LCD, Skill enhancement through problem solving.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**
- to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have a sub-question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

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.
3. Fitts C., Groundwater Science, Academic Press, (2012).
4. Bear J., Hydraulics of Groundwater, Dover Publications, (2007).

Web links and Video Lectures (e-Resources):

- Students are encouraged to visit SWAYAM web site where there are several Massive Open Online Courses (MOOC), http://swayam.gov.in
- Students are encouraged to take the benefits of SWAYAM PRABHA- the direct to home (DTH) 34 channels telecasting educational programmes on 24x7 basis using GSAT-15 satellite. The channels are up-linked from BISAG-N, Gandhinagar.

Course outcome (Course Skill Set)

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

Sl. No.	Description
1	Understand Governing equation of Groundwater flow in Aquifer.
2	Know the models for Ground Water Analysis.
3	Analysis Steady State Well Hydraulics.
4	Study Artificial Recharge of Aquifers

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x	x			x			
CO2		x	x	x				
CO3	x	x		x	x	x		
CO4	x	x	x	x			x	x

Semester- 2

SPATIAL DATA ANALYTICS [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand various method of collecting the spatial data.
- To learn various processing techniques used to enhance, interpret data and extract information from spatial data set collected.
- To design Geospatial database to management and apply in modelling the real world application.
- To understand and apply the functionalities of location based services for management of water and land management.

Module-1	
Introduction to Drones, History of Drone/UAS/UAVs, payload, battery life, Specs for good results, Regulations of DGCA and Drone license, Pre, Post Flight planning- Flight execution and photography, data collection, Modelling and analysis of UAV data Introduction to mapping and modelling concepts, Understanding RTK, PPK and GCP's, Overview of popular data processing software platforms and functions. Image interpretations and analysis.	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Assignments.

Module-2	
Image processing and Photogrammetry: Aerial Triangulation, post possessing software's, Analyzing Data, Contouring, DEM, DSM, Cut, Fill, and Volumetric Measurement Calculation and orthophoto generation. **Advance Remote Sensing:** Airborne LIDAR, Terrestrial LIDAR, Mobile LIDAR, Close Range Photogrammetry,Videogrammetry, Integrated Sensor for Asset Mapping (Laser, Image Compass), RADAR, SAR, GPR	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Assignments.

Module-3

Location Based Services: Concept of Location, Introduction and General aspects of Location Based Services, Navigation System, Spatial Database, Middleware for LBS, Interoperability through standards, data collection, Data Transmission in Mobile communication systems, Architecture and Protocol for LBS, Network Architecture, Functional entities, Procedures, Privacy options in LBS, Location Intelligence Social Media Network, Crowd Sourcing, Data mining. **Advanced Analytics:** Geostatistical Analysis; Google Earth Engine, Virtual Reality, Artificial Intelligence, Machine Learning, Big Data Analytics, Block Chai.	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Understanding various Advanced Analytics techniques using Google Earth Engine.
Module-4	
Structured Query Language: Data definition in SQL, queries, update statements, views in SQL, DDL, and DML. Relation Database Management System, querying operation. Object–relational database management system (ORDBMS), Distributed databases, web services and XML, OLAP (Online Analytical Processing), OLTP (Online transaction processing).	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Assignments.
Module-5	
Python Scripting: Introduction, Environment setup, Debugging, Syntax, Variable Types, Operators, Decision statements, Loops, Numbers, Strings, Lists, Tuples, Dictionary, Modules, File I/O, Exceptions & Exception Handling, Arrays-2D, Classes& Objects, Classes & functions, Inheritance and Polymorphism.	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Assignments. Understanding Python script by its IDE's.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.

3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Elmasri R. and Navathe S.B., "Fundamentals of Database Systems", Benjamin/Cummings Publishing Co. Inc. (Addison- Wesley world student series), 2002.
2. Dr. R Nageswara Rao., "Core Python Programming" Second edition.

Reference books:

1. John R Jenson 'Introductory Digital Image Processing- A Remote Sensing Perspective" 4th Ed, 2016, Pearson.
2. R. A. Schowengergt, 'Techniques for Image Processing and Classification in Remote Sensing'; 1983

Web links and Video Lectures (e-Resources):

- ESRI web site.
- NASA web site.
- ISRO website.

Skill Development Activities Suggested

- Drone data acquisition & Processing.
- Data Manipulation, Processing & Analysis.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	To know the various method of collecting the spatial data.	L2
2.	To know processing techniques used to enhance, interpret data and extract information from spatial data set collected.	L2,L3,L4
3.	To design Geospatial database to management and apply in modelling the real world application.	L4,L6
4.	To understand and apply the functionalities of location based services for management of water and land management.	L2,L3,L5

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X		X		X		X	
CO2	X			X	X	X		X
CO3		X	X	X				
CO4			X	X	X		X	X

Semester- 2

SOIL EROSION AND CONSERVATION [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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.

Module-1	
Soil Erosion: Mechanism, Factors affecting, Its effects. Water Erosion: Mechanism, Types of erosion, Estimation and measurement of water erosion.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through the design problems on erosion estimation.

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.	
Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature study, Skill enhancement by problem solving on estimation of runoff and erosion due to wind.

Module-3	
Water Erosion Control: Principles, Land classification, Mechanical and Biological methods of water erosion control. Wind Erosion Control: Principles, Control measures.	
Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review.

Module-4	
Soil Conservation in Special Problem Areas: Soil conservation in hilly areas, control of gullies, Ravine 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.	
Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review, NPTEL lectures.

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.

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review, NPTEL lectures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. R.P. Tripathi, and H.P.Singh,.Soil Erosion and Conservation, New Age International (P) Ltd., Publishers.2015
2. 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
3. Rama Rao, M.S.V. (1974). Soil conservation in India, I.C.A.R., New Delhi

Reference Books:

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

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/126/105/126105012/
- https://archive.nptel.ac.in/content/storage2/courses/105101010/downloads/Lecture06.pdf
- https://nptel.ac.in/courses/126105016
- https://courseware.cutm.ac.in/courses/soil-water-conservation-engineering-and-structures/

Skill Development Activities Suggested

- Skill enhancement through the design problems on erosion estimation.
- Skill enhancement by problem solving on estimation of runoff and erosion due to wind.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Estimate the soil erosion	L1,L2,L3,L5
2.	Apply the appropriate soil erosion control measures in special problem areas.	L1,L2,L3,L4 and L6
3.	Apply suitable Land and Water Management practices in Semi-arid and Arid areas.	L1,L2,L3,L4 and L6

Mapping of COs and POs

	PO 1	PO 2	PO 5	PO 6	PO 7	PO8
CO1	-	×	-	×	×	×
CO2	×	-	×	×	×	×
CO3	×	-	×	×	×	×

Semester- 2

INTEGRATED SOLID WASTE MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To provide detailed knowledge and skills and provide employability in solid waste management.
- To provide detailed knowledge of collection, 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.

Module-1

Evolution of Solid Waste management – SWM, ISWM, consequence, waste generation, development of SWM & ISWM, Operation of SWM System and its problems.
Legislative trends and impacts- Federal legislation, Governmental Agencies, future trends.

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through the design problems on erosion estimation.

Module-2

Sources, composition and Properties of solid waste: Types of material recovered from MSW, future changes in waste composition. Physical. Chemical and biological properties of MSW.
Sources, types and properties of hazardous waste found in MSW.
Solid waste Generation and collation rates, Waste handling and separation, storage and processing at the source. Engineering Classification.
Collection of Solid Waste- Types of waste collection, collection services, Collection Systems, Collection Equipment, and Collection Route Optimization.

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature study, Skill enhancement by problem solving.

Module-3

Transfer and Transport- Transfer Stations, Location and factors of Transfer Stations, Transfer Means and Methods.
Separation And Processing And Transformation Of Solid Waste: reuse and recycle, MRFs
Biological And Chemical Conversion Technologies: Aerobic composting and Anaerobic composting. Chemical Transformation Process, Energy production from biological conversion products.

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review.

Module-4

Thermal Conversion Technologies: fundamentals Combustion process. Incinerator and its types, pyrolysis, gasification, plasma gasification, energy recovery system.
Materials Separation And Processing Technologies: Unit operations, size reduction, size separation, density separation, magnetic and electric separation, densification.
Disposal method of SW using sanitary landfill : Landfill methods, types, factors, classification,

landfill design, landfill operation, landfill closure and post closure plan. Leachate and leachate treatment.	
Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review, NPTEL lectures.

Module-5

Other Type of Solid Waste: Biomedical waste management, Industrial waste management, E waste management, radioactive waste management, hazardous waste management .

Solid waste management and planning issues : 3 R, strategies for meeting diversion goals, Sources reduction, implementation of solid waste management options, planning siting and permitting of waste management facilities.

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review, NPTEL lectures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**
3. to attain the COs and POs
4. The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks.**
5. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Tchobanoglous G., Theissen H., and Eliassen R., "Solid Waste Engineering Principles and Management Issues", McGraw Hill, New York.
2. H.S. Peavy, D.R. Rowe, G. Tchobanoglous. Environmental Engineering, Mcgrow-Hill International Edition, 1st Edition, 2013.
3. George techobanoglous, Hilary T, Samuel A. V. "Integrated Solid Waste Management" engineering principles and, management issues. McGraw Hill, India private limited. New Delhi.

Reference Books:

1. Mantel C. L.,(1975), "Solid Waste Management", John Wiley
2. Pavoni J.L., "Handbook of Solid Waste Disposal".

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Skill enhancement through the problem solving.
- Skill enhancement by problem solving on SWM issues, case study analysis.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Understand and apply the basic scientific and sustainability principles behind waste management, for solving practical waste management challenges.	L1,L2,L3,L4, L5,L6
2.	Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of value from waste.	L1,L2,L3,L4, L5,L6
3.	Adopt suitable techniques, methods to solve solid waste management problems.	L1,L2,L3,L4, L5,L6

Mapping of COs and POs

	PO5	PO7	PO8
CO1	**X**	**X**	**X**
CO2	**X**	**X**	**X**
CO3	**X**	**X**	**X**

Semester- 2

URBAN FLOOD : PLANNING AND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the types and characteristics of urban flooding
- To understand the key climate uncertainties and expected consequences of climate change
- To acquire the knowledge of urban water cycle, flood damages, loss of life estimation and flood risk maps
- To understand the concept of sustainable flood response, IFRM, SPR model, NIPP
- To know the application of SUDS systems and FFWRS

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.	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Assignments

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	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Solving numerical, Assignments

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	
Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Group works, Assignments

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

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Group works, Assignments

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.

Teaching-Learning Process	Class seminars, Power Point Presentation, Group works

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

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.

Web links and Video Lectures (e-Resources):

- NDMA, Govt. of India: https://ndma.gov.in/Natural-Hazards/Urban-Floods
- KSNDMA, Govt. of Karnataka: https://www.ksndmc.org/
- NPTEL Materials: https://nptel.ac.in/courses/105101010
- Youtube lectures: https://www.youtube.com/watch?v=OVz4NxCKAMw

Skill Development Activities Suggested

- Flipped classroom activity
- Group works
- Solving Numerical

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Understand the characteristics of urban flooding and implication of climate change impacts	L2
2.	Assess different types of flood damages, loss of life and develop the flood risk maps	L3, L4
3.	Analyze urban water cycle and plan responses for sustainable flood management	L3, L4
4.	Adopt the SUDS/ WSUD techniques in urban landscapes and plan appropriate Flood forecasting, Warning and Response system	L3, L4

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X				X	X		X
CO2		X						
CO3		X	X	X		X		X
CO4			X				X	

Semester: 2

OPEN CHANNEL HYDRAULICS [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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.

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 continu ity, Energy equation, Momentum equation.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching, NPTEL Courses.

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

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 Jersy, USA, 1993.
3. K.G. RangaRaju, Flow through open channels, TATA Mc GRAW HILL Publishing Company Limited, New Delhi

Reference Books:

1. Chow, V.T., "Open Channel Hydraulics", McGraw-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, McGraw Hill Book Co., New York, 1985

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105/106/105106114/

Skill Development Activities Suggested

- Skill enhancement through problem solving,
- Skill enhancement through web searching,
- Skill enhancement through attending NPTEl courses.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Sketch the Pressure and Velocity distribution across various channel sections	L1,L2,L3,L4
2.	Determine critical depth and hydraulic exponents for flow through various channel sections.	L2,L3,L4
3.	Estimate normal depth under uniform flow condition through different prismatic channels sections.	L2,L3,L4
4.	Sketch the water surface profiles under gradually varied flow conditions.	L1,L2,L3,L4,L5
5.	Estimate the energy dissipation in hydraulic jump.	L2,L3,L4,L5

Mapping of COs and POs

	PO1	PO4	PO5	PO6	PO7	PO8
CO1	×	-	×	×	-	-
CO2	×	×	×	×	×	-
CO3	-	×	×	×	×	-
CO4	-	×	-	×	×	×
CO5	×	×	×	×	×	-

Semester: 2

INDUSTRIAL SAFETY HEALTH AND ENVIRONMENTAL MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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.

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

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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 non-destructive testing.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching, NPTEL Courses.

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

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.

3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. R.K.Jain and Sunil S.Rao , I**ndustrial Safety , Health and Environment Management Systems,** Khanna publishers , New Delhi (2006)
2. Slote.L,Handbook of **Occupational Safety and Health**, John Willey and Sons, NewYork .

Reference Books:

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.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=LSWiBaIao04
- https://www.youtube.com/watch?v=ZB_BIKBZ-Ow&list=PL3f_ghgGfVfL9CSZ7ZoSVL_aaXk-QqYR8
- https://www.youtube.com/watch?v=TYs3P8OQa-s

Skill Development Activities Suggested

- Literature review
- Case study
- Industrial visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Contribute to the development and maintenance of a healthy and safe work environment	L1,L2,L3
2.	Interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces	L1,L2,L3
3.	Apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards	L1,L2,L3,L4
4.	Collect, manage, and interpret information and data to identify trends and issues in the workplace	L1,L2,L3
5.	Design, support, and evaluate health and safety programs and implement procedures using project management principles and processes appropriate to the task.	L1,L2,L3,L4, L5
6.	Affect/manage change by advancing OH&S principles within management systems, cultures, practices, and priorities.	L1,L2,L3,L4, L5,L6

Mapping of COs and POs

	PO3	PO5	PO7	PO8
CO1	X	X	X	X
CO2	X	X	X	X
CO3	X	X	X	X
CO4	X	X	X	X
CO5	X	X	X	X
CO6	X	X	X	X

Semester: 2

WETLAND MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	25 hrs of teaching +10-12 sessions of SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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.

Module-1	
Introduction: History, definition of wetlands, Wetland indicators, Wetland Laws, National wetland inventory, Status and trends of wetlands, The Ramsar Convention.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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 indictors, Methods-preliminary data gathering and synthesis, Selection of methods.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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. .	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching, NPTEL Courses.

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books :

1. William J. Mitsch, James G. Gosselink, "Wetlands", Published by John Wiley and sons, Inc., Hoboken, New Jersy, Canada
2. Falconer, R. A and Goodwin, P (Ed), "Wetland Management", 1994, Thomas Telford, London.

References:

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.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=IeZYYlcf61Q
- https://www.youtube.com/watch?v=wSc1ANmsLK0

Skill Development Activities Suggested

- Case study analysis
- Literature review

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Explain a history of wetlands and define a Wetland	L1,L2
2.	Delineate wetlands based on different classifications	L1,L2,L3,L4
3.	Identify major wetland indicators i.e. Hydrology, Hydric soil and Hydrophytes	L1,L2,L3,L4, L5
4.	Apply different techniques for wetland conservation, restoration and creation	L1,L2,L3,L4, L5,L6

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	**X**	**X**	**X**	**X**	**X**	**X**		
CO2	**X**	**X**	**X**	**X**	**X**	**X**		
CO3	**X**	**X**	**X**	**X**	**X**	**X**		
CO4	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Semester: 2

GEOSPATIAL LABORATORY [As per Choice Based Credit System (CBCS) scheme			
Course Code	22 WLM L26	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	01:02:00 12 hrs of teaching +10-12 sessions of practical's	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

- To model and analyse the spatial data (vector & raster).
- To Design and develop of Geo-database.
- Understand how to use a wide range of vector based GIS tools to address quarries relevant to water and land management.
- To Process, Analyse and Classification of the raster data.

Sl. No.	Experiments
1	Map registration/ Map projection. Digitization of Points, lines & polygons. Preparing Application oriented Maps
2	ER Diagram.
3	Design of Geo-database.
4	Geo-Processing of Spatial Data. (Vector based analysis)
5	Geo-Processing of Spatial Data. (Raster based analysis)
6	Network Analysis and creation of DEM and TIN.
7	Downloading Satellite images from different websites NRSC, USGS etc., Mosaicing and Subsetting Radiometric Correction of Satellite Images.
8	Digital Image Classification- Supervised, Unsupervised.
	Demonstration Experiments (For CIE) if any
9	Introduction to QGIS tools, techniques and Watershed Delineation.
10	Demonstration of Drone and DGPS application for mapping.
11	Semi Automation algorithm using QGIS.
12	Introduction to Python/Java script And Google Earth Engine.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

  The duration of SEE is 03 hours

Course outcomes (Course Skill Set):

On completion of this laboratory studies students are able

1. Analyse the spatial data.
2. Design and develop Geo-database.
3. To use a wide range of vector based GIS tools to address quarries relevant to water and land management.
4. Process, Analyse and classification of the raster data.

Semester- 3

ADVANCE IRRIGATION ENGINEERING [As per Choice Based Credit System (CBCS) scheme			
Course Code	22 WLM 31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:02	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching + 10-12 of sessions of SDA	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- To know various methods and advanced techniques of irrigation in India,
- To understand soil water movement in the root zone of agricultural crops,
- To know water requirement for various crops and to estimate the duration and frequency for irrigation.
- To study water conveyance method and design,
- To know the various methods of land reclamation subjected to water logging and salinity.

Module-1

Necessity of irrigation, Advantages and Disadvantages of irrigation, Types & Techniques of Irrigation including advanced techniques, Irrigation development after Independence, Present situation of irrigation in India, Future possibilities of Irrigation Development.

Soil properties, Soil classification, Classification of soil water, Soil water constants, Importance of water in plant growth, Irrigation water quality,Functions of Irrigation Water,Soil-Moisture-Irrigation Relationship, Estimating depth and frequency of irrigation.

Water Requirements and Irrigation Planning, Factors Affecting Irrigation Interval, Optimum Utilization of Irrigation Water, Crop Seasons in India, Effect of Water Stress on Crops.

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, Skill enhancement through problem solving.

Module-2

Farm Size, Importance of land preparations, Small-scale land levelling, Land Capability classification, The various classes and their characteristic, Significance of Land Capability Classification in Land use Planning:

Types of Agriculture based on its dependence on water, Irrigation Return Flow, Indian Agriculture, Modern agricultural revolution, Modern commercial agriculture, Structures in Irrigation Systems, Modern Machines in Agriculture, Farm Hand Tools, Agricultural Machinery, Equipment and Tools.

Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, online sources.

Module-3

Crop Seasons and Categories of Crops in India, Multiple Cropping,Hybrid Cropping, Crop Period, Base Period, Delta of a Crop, Duty, Duty-Delta-Base Period Relation,Factors Affecting Duty, Irrigation Efficiencies, Determining Irrigation Requirement of Crops, Irrigation Scheduling.

Consumptive use of Crops- Blanney-Criddle method, Thornthwait penman method, scope of computerization in irrigation.

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving.

Module-4	
Losses in water canals, Computing the capacity of canals, Canal networks, Typical cross sections of canal-Unlined and Lined. Balancing depth, Types of lined canals, Design of lined canals.	
Teaching-Learning Process	Black board, LCD, NPTEL Courses, Skill enhancement through problem solving.
Module-5	
Causes for water logging and salinity, Impact of water logging and salinity, Design of surface and subsurface drains, Saline and alkaline lands reclamation and management of Salt affected lands.	
Teaching-Learning Process	Black board, LCD, NPTEL Courses, Literature study, online sources.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

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.

Reference Books:

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

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105102159
- https://onlinecourses.nptel.ac.in/noc20_ag04/preview.

Skill Development Activities Suggested

- Skill enhancement through problem solving,
- Skill enhancement through online sources,
- Skill enhancement through attending NPTEL courses.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Chose a suitable method and techniques for crop irrigation.	L2,L3
2.	Estimate the water requirement for irrigation.	L2,L3,L5
3.	Determine duration and frequency of irrigation for the crop.	L2,L3,L4,L5
4.	Design canal system.	L3,L4,L5, L6
5.	Adopt suitable method to reclaim water logged and saline land.	L2,L3,L4,L5, L6

Mapping of COS and Pos

	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	×	×	-	×	×	×	×
CO2	×	×	×	-	×	-	×
CO3	-	×	×	×	×	×	×
CO4	-	-	×	-	×	×	×
CO5	-	×	×	×	×	×	×

Semester- 3

CLIMATE CHANGE [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hr of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To understand the interacting components climate systems.
2. To analysis observations of current and past changes of earth climate system.
3. To know the about the construction, evaluation and application of climate models.
4. To study projections of future climate change and possible impact.

Module-1

Weather

Weather and Climate, The Climate System, Processes, Temporal Variations, Statistical properties of Climate, Spatial Scales on Climate Variations.

Observations

Atmosphere, Cryosphere, Ocean, Carbon Cycle.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, video lecture.

Module-2

Paleoclimate

Methods, The Last Two Millennia, The Holocene, The Ice Ages, Milankovitch Theory.

Theory

Electromagnetic Radiation: Interaction of electromagnetic radiation with matter, The Greenhouse Effect, Earth's Energy Budget, RadiativeForcings, Feedback Processes, and Climate Sensitivity.

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Analysis of historical data.

Module-3

Biogeochemical cycles:

a) The Natural Carbon Cycle, b) Anthropogenic Carbon, c) Carbonate Chemistry and Ocean Acidification.

d) Processes:

i) Atmospheric Circulation, ii) The Hydrologic Cycle, iii) Ocean Circulation.

Teaching-Learning Process	Black board, Power Point Presentation, Video lecture.

Module-4

Models: a) Construction: boundary conditions, initial conditions, zero-dimensional (OD) Energy Balance Model (EBM),one-dimensional EBM (1D-EBM). Three-dimensional GCMs, regional climate models.

b) Evaluation.

c) Applications: Pale climate model studies, Detection and attribution studies.

Teaching-Learning Process	Black board, Power Point Presentation, Analysis of the scenarios using MTLAB programming.

Module-5

Impacts:

a) Projections: Uncertainties, b) Ecosystems: Vegetation models, Wildfires, Ocean ecosystems, c) Long-Term Changes, d) Regional Changes, e) Extremes, f) Impacts on Humans.

Economics

Economics and the climate change challenge: Understanding incentives and policies.

Teaching-Learning Process	Black board, Power Point Presentation, Video lecture.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

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.
3. Introduction to Climate Science by Andreas Schmittner (online Edition)

Reference Books:

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.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.swayam2.ac.in/nou21_ge37/preview
- https://www.youtube.com/watch?v=KBKD6zDXckk

Skill Development Activities Suggested

- Analysing the case study of climate data.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Understand the interacting components climate systems.	L1,L2, L3
2.	Analysis observations of current and past changes of earth climate system.	L3,L4
3.	Know the about the construction, evaluation and application of climate models.	L4,L5
4.	Study projections of future climate change and possible impacts.	L4,L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X				X			X
CO2		X	X	X		X	X	X
CO3	X		X	X	X	X		
CO4			X	X	X		X	X

Semester: 3

WATER MANAGEMENT: CONSERVATION, HARVESTING AND ARTIFICIAL RECHARGE [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 322	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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.

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.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching,

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,

Teaching-Learning Process	Black board, LCD, Literature study, Web searching,

Module-3

Rain Water Harvesting: Introduction, Rain Water Harvesting, Roof Water Harvesting, Water Harvesting by Ponds, Water Quality Consideration.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching, NPTEL Courses.

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.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching, NPTEL Courses.

Module-5	
Methods of Artificial Recharge Practiced by People in Drought Prone Area, Well Clogging Mechanism and their Prevention, Cleaning of Injection Wells.	
Teaching-Learning Process	Black board, LCD, Literature study, Web searching,

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

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 Olsthoorm, 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.
3. UNDP (1998, 2001), State of the environment, India, United Nation Environmental Program.

Web links and Video Lectures (e-Resources):

- http://cgwb.gov.in/documents/Manual%20on%20Artificial%20Recharge%20of%20Ground%20Water.pdf
- https://cpwd.gov.in/Publication/rain_wh.pdf

Skill Development Activities Suggested

- Skill enhancement through web searching,
- Skill enhancement through attending NPTEL courses.

Course outcome (Course Skill Set)

- 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.

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

Sl. No.	Description	Blooms Level
1.	Estimate the various kinds of water losses.	L1,L2,L3,L4
2.	Apply appropriate water conservation methods.	L2,L3,L4
3.	Use most suitable water harvesting technology for the area.	L2,L3,L4
4.	Adopt most suitable artificial recharge method for the situation.	L1,L2,L3,L4, L5

Mapping of COs and POs

	PO1	PO4	PO5	PO6	PO7	PO8
CO1	×	-	×	×	-	-
CO2	×	×	×	×	×	-
CO3	-	×	×	×	×	-
CO4	-	×	-	×	×	×
CO5	×	×	×	×	×	-

Semester: 3

WASTE WATER RECLAMATION AND REUSE [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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.

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.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching,

Module-2

Reuse Of Wastewater Using Aerobic 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.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching,

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.

Teaching-Learning	Black board, LCD, Literature study, Web searching, NPTEL Courses.

Process	

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.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching, NPTEL Courses.

Module-5

Recent Advancement of Wastewater Reclamation and Reuse: New polices, Role of Governmental 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.

Teaching-Learning Process	Black board, LCD, Literature study, Web searching,

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**
- to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

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 Chiffs, 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

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105105178
- https://nptel.ac.in/courses/105107207

Skill Development Activities Suggested

- Skill enhancement through web searching,
- Skill enhancement through attending NPTEL courses.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Adopt appropriate treatment methods for municipal and certain industrial effluents and management of wastewater treatment plants. And the Simple design equations for water and wastewater treatment plant.	L1,L2,L3,L4
2.	Design and operation of wastewater treatment plant and the management of residuals from water and wastewater treatment.	L1,L2,L3,L4, L5
3.	The Complete understanding of the Recent Advancement of Wastewater Reclamation and Reuse, Rural wastewater systems.	L1,L2,L3
4.	Implementation of Risk Assessment, Legal Aspects, Health Aspects with respect to wastewater Reclamation and Reuse and Advanced Wastewater Treatment.	L1,L2,L3,L4, L5,L6
5.	To design the physical, chemical and biological reactors for the treatment, reuse and recycle of waste water.	L1,L2,L3,L4, L5

Mapping of COs and POs

	PO4	PO5	PO6	PO7	PO8
CO1	X	X			
CO2	X	X	X		
CO3	X	X			
CO4	X	X		X	X
CO5	X	X	X		

Semester- 3

ENVIRONMENTAL MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To study the principle of environmental management.
- To learn and study the policy of legal aspect of environmental management.
- To study the purpose, stages and necessity of EIA.
- To learn the EIA documentation and process.
- To understand the purpose and necessity of environmental auditing.
- To study the stages involved in environmental auditing.
- Understand the life cycle assessment.
- Understanding the environmental management techniques, environmental monitoring and modelling.
- To study the principal of environmental design and benefits.
- To understand the environmental economics, environmental valuation and economics of natural resources.

Module-1

Principles of Environmental Management: Introducing Environmental Management, Ecosystem Concepts, Participants in EM, Ethics and Environment, International Environmental Movement, Environmental Concerns in India.

Policy and Legal Aspects of EM: Introduction to Environmental Policies, Environmental Policies and Programmes in India, Environmental Laws and Legislations, Environmental Legislations in India.

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through the design problems on erosion estimation.

Module-2

Environmental Impact Assessment (EIA): Introduction to EIA, Evolution of EIA, Forecasting Environmental Changes, Strategic Environmental Assessment (SEA), Environmental Clearance Procedure in India.

EIA Documentation and Processes: Preliminary Stages of EIA, Impact Prediction, Evaluation and Mitigation, Impact on Decisions, Participation Requisites and Review, EIA Monitoring and Auditing.

Teaching-Learning	Black board, By audio-Visual facility, LCD, Literature study, Skill enhancement by problem solving.

Process	

Module-3

Environmental Auditing: Introduction to Environmental Auditing(EA), General Audit Methodology, Element of Audit Process, Waste Audits and Pollution Prevention Assessments, EA in Industrial Projects, Liability Audits and Site Assessments, Auditing of EMS.

Life Cycle Assessment: Evolution of Life Cycle Assessment, Stages in Product LCA, A Code of Good Conduct for LCA, Procedure for LCA, Different Applications of LCA.

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review.

Module-4

Environmental Management System Standards: Environmental Management Systems (EMS), EMS Standards: ISO 14000 Series, Implementation of EMS Conforming to ISO 14001, Benefits of Implementing ISO 14001: An Indian Scenario.

Environmental Management Techniques: Environmental Monitoring, Environmental Modelling, Sensitivity Analysis, Application of Remote Sensing and GIS in EM, Environmental Profile, Environmental Technology Assessment, Environmental Risk Assessment, Rapid Urban Environmental Assessment, Ecco-Mapping, Environmental Education.

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review, NPTEL lectures.

Module-5

Environmental Design: Environmental Design (ED): An Exposition, ED For Manufactured Products, ED For Buildings, ED for Developmental Planning.

Environmental Economics: Economics and the Environment, Environmental Valuation, Economics of Natural Resources, Environment and Regional Economics, Ecological Economics

Teaching-Learning Process	Black board, By audio-Visual facility, LCD, Literature review, NPTEL lectures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**
- to attain the COs and POs
- The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
- **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module .

Suggested Learning Resources:

Text Books:

1. Vijay Kulkarni., T.V. Ramachandra., "Environmental Management"
2. Iyyanki V.Muralikrishna and Valli Manickam "Environmental Management"

Reference Books:

1. M.C. Dash " Concepts of Environmental Management for Sustainable Development"
2. Simon J.R. MacDonnell., Chris MacDonnell., "An Introduction to Environmental Management"

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Case study
- Literature review
- Field visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Implement environmental management plan in to practice.	L1,L2,L3
2.	Implement legal aspects of environmental management in to practice.	L1,L2,L3
3.	Carryout the EIA process as per industries requirement.	L1,L2,L3,L4, L5,L6
4.	Carryout the environmental auditing and lifecycle analysis for the assigned project.	L1,L2,L3,L4, L5,L6
5.	Carryout the environmental monitoring, modelling and risk assessment in industry, ecosystem urban development.	L1,L2,L3,L4, L5,L6
6.	Carryout the environmental design for planning and buildings.	L1,L2,L3,L4, L5,L6
7.	Carryout the environmental cost benefits analysis, environmental valuation, and economics of resources and ecological economics.	L1,L2,L3,L4, L5,L6

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		X	X	X	X		X	X
CO2					X		X	X
CO3	X	X	X	X	X	X	X	X
CO4	X	X	X	X	X	X	X	X
CO5	X	X	X	X	X	X	X	X
CO6	X	X	X	X	X	X	X	X
CO7	X	X	X	X	X	X	X	X

Semester- 3

ENVIRONMENTAL IMPACT ASSESSMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- 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 measure

Module-1

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

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Group works, Assignments

Module-2

EIA Methodologies/Techniques of EIA:- checklist, matrix, network analysis, environmental index, overlay, simulation method and cost benefit analysis technique.

Teaching-Learning Process	Power Point Presentation, Group works, Solving Numerical, Assignments

Module-3

Assessment and Prediction of Impacts of ecological attributes and mitigation measures - Air, Surface-Water, Noise, Soil and Groundwater and Biological Environment

Teaching-	Black-Board Teaching, Power Point Presentation, Illustrative Videos, Case Studies,

Learning Process	Group works, , Assignments

Module-4

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 n EIA

Teaching-Learning Process	Black-Board Teaching, Power Point Presentation, Group works, Flipped classroom, Assignments

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, and Textile industries.

Teaching-Learning Process	Power Point Presentation , Class seminars, Group works, Flipped classroom, Assignments

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

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

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

Web links and Video Lectures (e-Resources):

- MoEF,CC Govt. of India: http://environmentclearance.nic.in/
- NPTEL Materials: https://onlinecourses.nptel.ac.in/noc22_ar07/preview
- Swayam Material: https://onlinecourses.swayam2.ac.in/nou21_bt02/preview

Skill Development Activities Suggested

- Flipped classroom activity
- Group works
- Solving Numerical
- Case study analysis

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Know the importance of EIA, objectives and scope of EIA	L2
2.	Understand various Methodologies/Techniques required for Impact Identification and Analysis	L3, L4 and L5
3.	Assess and Predict the Impacts on various ecological attributes	L3, L4 and L5
4.	Understand the techniques to implement different mitigation measures	L3, L4 and L5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1			X					
CO2			X	X		X		X
CO3	X	X	X	X	X	X	X	X
CO4			X	X	X		X	X

Semester: 3

ADVANCED REMOTE SENSING [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To gain the knowledge of different Platforms and Sensors.
- To study the principals and application of optical, microwave and thermal remote sensing.
- To acquire the skills of Image interpretation and analysis.
- To perform various Digital Image processing techniques.

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	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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.	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

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 .	
Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching, NPTEL Courses.

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 **Image Interpretation and Analysis:** Fundamentals of satellite image interpretation; Types of imaging, elements of interpretation; Techniques of visual interpretation; Generations of Thematic maps.	
Teaching-	Black board, LCD, Literature study, Skill enhancement through problem solving. Web

Learning Process	searching,

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.

Teaching-Learning Process	Black board, LCD, Literature study, Skill enhancement through problem solving. Web searching,

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

- Students are encouraged to visit SWAYAM web site where there are several Massive Open Online Courses (MOOC), http://swayam.gov.in
- ISRO-IIRS outreach programme and conducting live & Interactive courses at our Institute/Organization

Text Books :

1. George Joseph, —Fundamentals of Remote Sensing‖, Universities Press, 2005
2. P. J. Curran, —Physical aspects of Remote Sensing‖, Longman Group Limited, London.

Reference Books:

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. 3. Robert A. Schowengerdt —Remote sensing Models and methods for image processing‖, Second edition, 1997, Academic Press.

Web links and Video Lectures (e-Resources):

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

Skill Development Activities Suggested

- Literature review
- Software learning
- Case study
- Field visit
- Hands on training

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Have sound knowledge of different platforms and sensors	L1, L2
2.	Understand principals and application of optical, microwave and thermal remote sensing	L1, L2
3.	Perform Image interpretation and analysis.	L3,L4,L5
4.	Perform Digital Image processing techniques.	L3,L4,L5,L6

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	X		X	X	X			
CO2		X		X		X	X	
CO3	X	X	X			X		X
CO4	X	X	X		X	X		X

Semester: 3

ENVIRONMENTAL DISASTER MANAGEMENT [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the disasters and their impacts over the built environments and the recovery policy andframeworks.
- To impart knowledge of identifying improved disaster resilience opportunities using project managementapproach.
- To familiarize the students with various disaster recovery planning and reconstruction activities.

Module-1

Introduction: – types of disaster – geological disasters, hydro meteorological disasters, biological disasters, technological disasters, manmade disasters, global disasters; relationship between disaster and redevelopment;rehabilitation and reconstruction; Role of project management in disaster planning and reconstruction projects; method, tools, processes, practices and knowledge areas in managing disaster recovery and reconstruction.

Teaching-Learning Process	**Direct method:** Lecture supported by conventional method of Blackboard and chalk to introduce the concept

Module-2

Disaster recovery and reconstruction framework: Case studies of management of large scale disaster projects; experiences and lessons learnt; factors affecting success / failure of disaster planning and management; measurement of performance of disaster recovery projects; Governance and organization of disaster planning and recovery; multiple stakeholder management and coordination; professionalism and ethics of disaster planning and reconstruction; disaster planning and reconstruction policies and standards; innovative and participatory approach to disaster management.

Teaching-Learning Process	**Direct method:** Lecture supported by conventional method of Blackboard and chalkto introduce the concept. **ICT and Digital support:** Video and Power point presentation to elaborate the disaster recovery and reconstruction framework.

Module-3

Post disaster damage and assessment: Disaster damage and need assessment – effects and impacts of disaster – damage and loss assessment (DALA) – Human recovery needs assessments (HRNA)-Summary of assessment process – Post disaster need assessment deliverables – Issues and challenges in PDNA – Involvement of government in assessment process – Mega disasters of India and lessons learnt disaster management act -2005; National guidelines and plans on disaster management; role of government (local, state and national), role of non-government and inter – governmental agencies.

Teaching-Learning Process	**ICT and Digital support:** Video and power point presentation to explain about the post disasterdamage and assessment

Module-4

Recovery and reconstruction planning:

Recovery planning – Policy – Key points to be considered for recovery policy – Basic structure of recovery and reconstruction plan – key areas of recovery and reconstruction planning – Issues and challenges in livelihood recovery Community safety and disaster resilience; predicting disasters, and appropriate response management; risk management in disaster planning and reconstruction; identification of risks; role of Geo-informatics, land useplanning and development regulations, disaster safe designs; structural and non-structural mitigation of disasters.

Teaching-Learning Process	**ICT and Digital support:** Video and power point presentation to explain about theRecovery And Reconstruction Planning **Collaborative and Cooperative learning**: Selected topics to be given as seminarGroup work. The research and learning to share with the class.

Module-5

Constructive assessments:

Identifying and analysing the case studies of disaster, and do the study on the type of disaster and damage assessment basis the impact. Propose and justify the suitable recovery and resilient reconstruction planning for the particular development. Also identify and justify the project management approach suitable for such recovery and reconstruction planning.

Teaching-Learning Process	**Collaborative and Cooperative learning**: Selected topics to be given as seminar/group work and theresearch and learning to be shared with the class.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. W.Nick Carter, Disaster Management, A disaster manager's handbook, 2008.
2. S. Vaidyanathan, an Introduction to disaster management, natural disasters and manmade hazards, ikonbooks, New Delhi, 2011
3. Harsh K.Gupta, Disaster Management, universities press 2003

Reference Books

1. Damon P.Coppola, Introduction to International disaster management, Elsevier Inc, 2011
2. Palanivel K, Saravanavel J, Gunasekaran S, Disaster Management, Allied Publishers Pvt.Ltd, 2015
3. Dr.ParagDiwan (Ed), A manual on disaster management, Pentagon Press, New Delhi, 2010India.

Web links and Video Lectures (e-Resources):

- http://www.ndmaindia.nic.com
- http://www.nidm.gov.in

Skill Development Activities Suggested

- Disaster preparedness, response, recovery and mitigation for a specific type of disaster.
- Exploring on temporary structures for rehabilitation..

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Interpret the Understanding of the various types of disasters and their impact over the built environment and society.	L2
2.	Analyze the impact of the disaster and their damages and understanding of suitable disaster recovery framework	L4
3.	Categorize the type of post disaster damages and understand the possible resilient reconstruction strategies	L4
4.	Surveying the factors influencing the proper implementation of reconstruction planning	L4
5.	Analyze the stakeholders involved and their role in implementing the reconstruction.	L4
6.	Analyze the major case studies and their resilient planning and reconstruction strategies implemented	L4

Mapping of COs and POs

	PO2	PO3	PO5	PO6	PO7	PO8
CO1				**X**		**X**
CO2	**X**			**X**		
CO3		**X**	**X**		**X**	**X**
CO4	**X**					
CO5	**X**		**X**		**X**	
CO6		**X**	**X**		**X**	**X**

Semester: 3

RENEWABLE ENERGY AND ALTERNATIVE FUELS [As per Choice Based Credit System (CBCS) scheme]			
Course Code	22 WLM 334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:00:00	SEE Marks	50
Total Hours of Pedagogy	40 hrs of teaching	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To create awareness in students familiar about importance of alternative fuels.
- To teach combustion and emission characteristics of various gaseous and liquid alternative fuels.
- To teach adaptability of engines to alternative fuels.

Module-1	
Introduction to energy and resources – Renewable energy sources - Availability of solar energy – Sun-earth relationships - - Solar radiation measurement – Flat plate collectors – Solar water heating systems – Evacuated Tubular Concentrators - Solar air heating systems and applications – Concepts on solar drying, cooking, desalination, solar ponds and solar cooling - Passive heating and cooling of buildings – Basics of solar concentrators and types Solar thermal power generation.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and Video Lecture
Module-2	
Biomass to energy conversion processes – Anaerobic digestion, process parameters, biogas composition, digester types, high rate anaerobic conversion systems – Alcohol from biomass – Biodiesel: preparation, characteristics and application - Biomass combustion and power generation – Briquetting – Gasification: Process, types of gasifiers, Applications – Waste to energy technologies	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and Video Lecture.
Module-3	
Power in the wind - Types of wind mills – WEG components, Power curves and energy Estimation– Indian wind potential. Small Hydro Power: Types, site identification, head and flow Measurement, discharge curve, estimation of power potential and system components. Technologies for harnessing renewable energy sources like geothermal, wave, tidal and ocean Thermal energy.	
Teaching-Learning Process	Chalk and Talk, Power Point Presentation and Video Lecture.
Module-4	
Fossil fuels and their availability - Potential alternative liquid and gaseous fuels - Merits and demerits of various alternative fuels - Engine requirements Methods of production - Properties - Blends of gasoline and alcohol - Performance in SI engines – Adaptability - Combustion and emission characteristics - Performance in CI engines - Emission Characteristics - Properties of alcohol esters. Production and properties of CNG, LPG, hydrogen gas, biogas and producer gas - Performance and Storage, distribution and safety aspects.	
Teaching-Learning	Chalk and Talk, Power Point Presentation and Video Lecture.

Process	

Module-5

Various vegetables oils - Properties - Esterification - Performance and emission characteristics - Bio-diesel: Feed stock, characteristics, preparation (lab and commercial), storage, applications, Environmental impacts, economics, policy.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation and Video Lecture.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks or one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1. Frank Kreith and D.YogiGoswami (2007), Handbook of Energy Efficiency and Renewable
2. Energy, CRC Press.
3. John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.
4. John A. Duffie and William A. Beckman (2006), Solar Engineering of Thermal Process, 3rd Edition, John Wiley & Sons.

Reference Books

1. Gilbert M. Masters (2004), Renewable and Efficient Electric Power Systems, Wiley Interscience.
2. Samu Hirao and Richard Pefley (1988), Present and Future Automotive Fuels, Wiley Interscience Publication, New York

3. Alcohols and Motor Fuels: Progress in Technology - Series No. 19 - SAE Publication USA C.

Web links and Video Lectures (e-Resources):

- https://www2.tulane.edu/~sanelson/eens1110/energy.htm
- https://www.eia.gov/energyexplained/biomass/
- https://www.iberdrola.com/sustainability/renewables-energy-wind-power
- https://www.hydropower.org/iha/discover-types-of-hydropower
- https://www.britannica.com/science/fossil-fuel

Skill Development Activities Suggested

- Visit to the nearby renewable energy plants

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
1.	Learn need for alternative fuels.	L1
2.	Learn sources of various alternative fuels.	L1,L2
3.	An understanding limitation of fossil fuels and combustion Characteristics fuels.	L3

Mapping of COs and POs

	PO3	PO5	PO6	PO7	PO8
CO1	X				X
CO2	X	X		X	X
CO3			X		X

Semester III

PROJECT WORK PHASE – 1			
Course Code	22 WLM 34	CIE Marks	100
Number of contact Hours/Week (L:P:S)	00:06:00	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.

SOCIETAL PROJECT			
Course Code	22 WLM 35	CIE Marks	100
Number of contact Hours/Week (L:P:S)	00:06:00	SEE Marks	--
Credits	03	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the societal Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected societal project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Demonstrate a sound technical knowledge of their selected societal project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.

Semester III

INTERNSHIP			
Course Code	22 WLM I36	CIE Marks	50
Number of contact Hours	06 Weeks	SEE Marks	50
Credits	06	Exam Hours	03

Course objectives:

Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.

Semester IV

PROJECT WORK PHASE -2			
Course Code	22 WLM 41	CIE Marks	100
Number of contact Hours/Week (L:P:S)	00:08:00	SEE Marks	100
Credits	18	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.