ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF ENGINEERING & TECHNOLOGY

(RSET)

SYLLABUS

&

COURSE STRUCTURE

M.TECH. (CE)

Water Resources Development &Management (WRDM)

Scheme of Evaluation

Theory Papers (T):

- Continuous Evaluation: 15%
  (Any Three of Assignment, Class Test, Viva, Seminar, Quiz)
- Mid-term examination: 10%
- Attendance: 5%
- End Term Examination: 70%

Practical Papers (P):

- Continuous Evaluation: 25%
  (Any Three of Skill Test, lab copy, viva, lab involvement)
- Attendance: 5%
- End term examination: 70 %

Combined Theory & Practical Papers (TP):

- Continuous Evaluation: 15%
  (Any Three of Assignment, Class Test, Lab Experiment, Lab Copy, Viva)
- Mid-term examination: 10%
- Attendance: 5%
- End term examination: 70 %

Table of Contents

1. Introduction

Water Resources Development and Management is a sub-discipline of Civil Engineering and Master of Technology in Water Resources Development & Management is a postgraduate Water Resource Engineering programme. The course emphasizes on the development and management of water, land and related resources, to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. The students are taught to develop understanding of effective water resource management and the need for economic growth. They are equipped to be able to identify and critically assess the different functions of the water resources system and the, often competing, interests of the various water users.

The duration of the course is two (2) years and after its successful completion, the students will have many job options. The course is suitable for those who are willing to go for teaching fields at higher degree level i.e. college and university level both in private and government institutions.

2. Learning Outcomes based approach to Curriculum Planning

The Course Curriculum has been designed to help students attain skills and knowledge required for employment. Framing and implementation of curricula and syllabi is envisaged to provide an understanding of the basic connection between theory and field, which is very critical in developing a scientific temperament and to venture into a career having a wide spectrum of applications as well as theoretical investigations. The curriculum provides students with theoretical foundations and practical experience in water resources engineering. The course learning outcomes are aimed at facilitating the learners to acquire knowledge, skills, understanding, values, attributes, and an academic standard that is acceptable to the industry and academia. A student is awarded with M. Tech. in Water Resources Development and Management (WRDM) on the basis of the attainment of these outcomes at the end of the 2-year programme.

2.1 Nature and extent of the programme

M. Tech. in Water Resources Development and Management (WRDM) is a 2-year degree program, aimed at developing advanced theoretical and research skills in the field of water resources engineering. This programme helps in building an advanced professional or academic career. The programme follows the Choice Based Credit System (CBCS) structure as mandated by the UGC. In accordance with CBCS guidelines the courses are categorized into compulsory courses, elective courses, ability enhancement courses. These categories of courses are discussed later on.

2.2 Aims of the Programme

The main aim of this Master's degree is to deliver a modern curriculum that will equip graduates with strong theoretical and practical backgrounds to enable them to excel in the workplace and to be lifelong learners. The purpose of this program is twofold:

(1) To prepare the students for a position involved in analysis, design, implementation and skillful execution of water resources engineering knowledge in practical solutions.

(2) To prepare the student for entry to research and innovation in Water Resources Engineering.

3. Learner's Attributes

Learner's Attributes (LA) are the qualities, skills and understandings that students should develop during their time with RGU. These are qualities that also prepare graduates as agents of social good in future. Graduate Attributes can be viewed as qualities in following sub-categories.

- Knowledge of the Discipline
- Creativity
- Intellectual Rigor
- Problem Solving and Design
- Ethical Practices
- Lifelong Learning
- Communication and Social Skills

Among these attributes, categories attributes under Knowledge of the Discipline are specific to the programme of study.

Knowledge of Discipline of Water Resources Development and Management

Knowledge of a discipline is defined as "command of a discipline to enable a smooth transition and contribution to professional and community settings. This Learner's Attribute describes the capability of demonstrating comprehensive and considered knowledge of Water Resources Development and Management. It enables students to evaluate and utilize information and apply their knowledge and their professional skills in the workplace.

Creativity

Creativity is a skill that underpins most activities in engineering irrespective of the branch. Students are required to apply innovative and reflective thinking to optimize the project cost coupled with increased safety and efficiency. Students are encouraged to look at the issues from the view of safety, economy and novel perspectives. Creativity allows the possibility of a powerful shift in outlook and enables students to be open to thinking about different concepts and ideas.

Intellectual Consistency

Intellectual consistency is the commitment to excellence in all scholarly and intellectual activities, including critical judgment. The students are expected to develop clarity in thinking. This capability involves engaging constructively and methodically when exploring ideas, theories, and philosophies. It also relates to the ability to analyse with depth, insight, and intellectual maturity.

Problem Solving and Design

Problem solving skills empower students not only within the context of their domain, but also in their personal and professional lives. Many employers cite good problem-solving skills as a desired attribute that they would like graduates to bring to the workplace. With an ability to seek out and identify problems, problem solvers are able to actively engage with a situation, think creatively, to consider different perspectives to address identified challenge, to try out possible solutions and subsequently evaluate results as a way to make decisions. Through this process they can consolidate new and emergent knowledge and develop a deeper understanding of their disciplines.

Ethical Practices

Ethical practice being a key component of professionalism, it has been incorporated in the curricula. When operating ethically, graduates are aware that we live in a diverse society with many competing points of view. Ethical behavior involves tolerance and responsibility. It includes being open-minded about cultural

diversity, linguistic difference, and the complex nature of our world. It also means behaving appropriately towards colleagues and the community and being sensitive to local and global social justice issues.

Life-Long Learning

The skill of being a lifelong learner means a graduate is open, curious, willing to investigate, and consider new knowledge and ways of thinking. This flexibility of mind means they are always amenable to new ideas and actively seek out new ways of learning or understanding the world.

Communication and Social Skills

The ability to communicate clearly and to work well in a team setting is critical to sustained and employment. The skill is necessary to convey different technical aspects of projects clearly and precisely. And social skills involve the ability to listen to, as well as clearly express, information back to others in a variety of ways - oral, written, and visual - using a range of technologies.

4. Qualification Descriptor

Qualification descriptors are generic statements of the outcomes of study. Qualification descriptors are a statement of outcomes, achievement of which a student should be able to demonstrate for the award of the degree of M. Tech. (CE-WRDM). It also states different capabilities a student could be expected to have developed that would be of assistance to employers and others with an interest in the general capabilities of holders of the qualification.

- A systematic, extensive and coherent knowledge and understanding of water resources as a whole and its applications, and links to related disciplinary areas; including a critical understanding of the established theories, principles and concepts, and of a number of recent, advanced and emerging issues in the domain of water resources engineering.

- Knowledgethat creates different types of professionals related to water resources engineering, including research and development, teaching, and government/public service.

- Skills in areas of water resources engineering and usage of tools and current developments, including a critical understanding of the latest developments in the area, and an ability to use established techniques of analysis and enquiry within the desired area.

- Demonstrate comprehensive knowledge, including current research, scholarly and/or professional literature, relating to essential and advanced learning areas pertaining to the chosen disciplinary areas (s) and field of study, and techniques and skills required for identifying problems and issues relating to the disciplinary area and field of study.

- Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.

- Communicate the results of studies accurately in a range of different contexts using the main concepts, constructs, and techniques of the subject(s) of study.

5. Programme Learning Outcomes

These outcomes describe what students are expected to know and be able to do by the time of post-graduation. They relate to the skills, knowledge, and behaviors that students acquire in their graduation through the program**.** The Master's Degree in water resources development and management program enables students to attain the following:

- Ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

- Ability to develop and conduct appropriate experimentation, analyse, and interpret data, and use engineering judgment to draw conclusions.

- Identify the main issues and strategies linked to water resource management

- Acquire the key reading material needed to understand the many variables (environmental, institutional and political) which affect water and which, in terms of management, may require adjustment.

- Make use of advanced software for creating modern avenues to succeed as an entrepreneur or to pursue higher studies.

THE ASSAM ROYAL GLOBAL UNIVERSITY							
ROYAL SCHOOL OF ENGINEERING & TECHNOLOGY							
Department of Civil Engineering							
M. Tech. (CE), Specialization: Water Resources Development & Management							
COURSE STRUCTURE- AS PER UGC							
SEM-I							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C10W1	Command Area Development and Management	3	1	0	4	4
2	CEE024C10W2	Remote Sensing for Land and Water Resources	3	1	0	4	4
3	CEE024C10W3	Applied Hydrology	3	1	0	4	4
4	CEE024C10W4	Ground Water Development and Tube wells	3	1	0	4	4
5	CEE024C10W5	Climate Change and Water Resources	3	1	0	4	4
6	CEE024C10W6	Research Methodology and Intellectual Property Right	2	0	0	2	2
7	CEE024C11W7	Hydrology & Water Resources Engineering Lab	0	0	2	1	2
8	CEE024C11W8	GIS Lab	0	0	2	1	2
9	CEE024C13W9	Seminar-I	0	0	4	2	4
Departmental Specific Elective (DSE)							
			0	0	0	0	0
Ability Enhancement Elective Course (AEEC)							
			0	0	0	0	0
Ability Enhancement Compulsory Course (AECC)							
10	CEN984A101	Communicative English-I	1	0	0	1	1
11	BHS982A104	Behavioural Science-I	1	0	0	1	1
		Total	**19**	**5**	**8**	**28**	**32**

SEM-II							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C20W1	Systems Analysis in Water Resources	3	1	0	4	4
2	CEE024C20W2	Sediment Transport	3	1	0	4	4
3	CEE024C20W3	Urban Water Resources Management	3	1	0	4	4
4	CEE024C20W4	Evaluation of Water Resources Projects	3	1	0	4	4
5	CEE024C20W5	Environmental Impact Assessment of Water Resource Projects	3	1	0	4	4
6	CEE024C23W6	Seminar-II	0	0	4	2	4
Departmental Specific Elective (DSE)							
7	CEE024D20W5	Elective-I	3	1	0	4	4
Ability Enhancement Elective Course (AEEC)							
8	CEE024S20W1	Disaster Management	2	0	0	2	2
Ability Enhancement Compulsory Course (AECC)							
9	CEN984A201	Communicative English-II	1	0	0	1	1
10	BHS982A204	Behavioural Science-II	1	0	0	1	1
		Total	**22**	**6**	**4**	**30**	**32**
		(Sem-I to II)	**41**	**11**	**12**	**58**	**64**

SEM-III							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C30W1	Watershed Conservation and Management	3	1	0	4	4
2	CEE024C30W5	Dissertation (Phase-I) and Presentation	0	0	24	12	24
3	CEE024C30W6	Summer Training Report (Undertaken at the end of Sem-II)	0	0	0	1	0
Departmental Specific Elective (DSE)							
4	CEE024D30W1	Elective-II	3	1	0	4	4
Ability Enhancement Elective Course (AEEC)							
5	CEE024S30W1	Forensic, Rehabilitation and Structural Health Monitoring	2	0	0	2	2
Ability Enhancement Compulsory Course (AECC)							
6	CEN982A301	Communicative English-III	1	0	0	1	1
		Total	**8**	**2**	**24**	**24**	**35**
		(Sem-I to III)	**49**	**13**	**36**	**82**	**99**
SEM-IV							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C43W2	Dissertation (Phase-II) and Presentation	0	0	36	18	36
2	CEE024C43W3	Publication of Technical Paper	0	0	0	1	0
Ability Enhancement Compulsory Course (AECC)							
3	CEN984A401	Communicative English-IV	1	0	0	1	1
		Total	**1**	**0**	**36**	**20**	**37**
		(Sem-I to IV)	**50**	**13**	**72**	**102**	**136**

Elective-I	**Elective-II**
Mathematical Models in Hydrology	Design of Drainage Systems
On Farm Water Management	Water Resources Planning & Management

SEM-I							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C10W1	Command Area Development and Management	3	1	0	4	4
2	CEE024C10W2	Remote Sensing for Land and Water Resources	3	1	0	4	4
3	CEE024C10W3	Applied Hydrology	3	1	0	4	4
4	CEE024C10W4	Ground Water Development and Tube wells	3	1	0	4	4
5	CEE024C10W5	Climate Change and Water Resources	3	1	0	4	4
6	CEE024C10W6	Research Methodology and Intellectual Property Right	2	0	0	2	2
7	CEE024C11W7	Hydrology & Water Resources Engineering Lab	0	0	2	1	2
8	CEE024C11W8	GIS Lab	0	0	2	1	2
9	CEE024C13W9	Seminar-I	0	0	4	2	4
Departmental Specific Elective (DSE)							
			0	0	0	0	0
Ability Enhancement Elective Course (AEEC)							
			0	0	0	0	0
Ability Enhancement Compulsory Course (AECC)							
10	CEN984A101	Communicative English-I	1	0	0	1	1
11	BHS982A104	Behavioural Science-I	1	0	0	1	1
		Total	**19**	**5**	**8**	**28**	**32**

SYLLABUS (1st SEMESTER)

Paper-I: Command Area Development & Management		**Scheme of Evaluation: Theory**
Subject Code: CEE024C10W1	**Credits: L-T-P-C : 3-1-0-4**	**Sem-I**

Prerequisites:

- Basic knowledge of surveying, hydrology, soil types and hydraulics

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Basics Concepts of Command Area Development	To impart basic concepts of command area development and management	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Understand the basic concepts of command area	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Irrigation Projects in a Command Area	To teach state of the art Irrigation management techniques employed in a command area			
III Application of GIS	To teach planning irrigation facilities within a command area on GIS platform		Students will learn to prepare CAD plans on GIS platforms	
IV Preparation of Command Area Development Plan	To teach preparation of CAD plans		Students will learn to prepare CAD plans and also carry out financial analysis	

Modules	Topics/course covered	Hrs.	Marks
I	**Basics Concepts of Command Area Development:** Definition, need, scope, & development approaches: historical perspective, command area development authorities; Interaction/collaboration of irrigation water use efficiency and agricultural production. Planning and execution of on farm development activities within the scope of command area development;	**10**	**25**
II	**Irrigation Projects in a Command Area:** Case study of Command Area Development Project in Assam; Farmers participation in command area development. Major, medium & minor irrigation projects-their comparative performance; development and utilization of water resources through different minor irrigation schemes-Indian scenario vs. the scenario in the state of Assam.	**10**	**25**
III	**Application of GIS:** Familiarization of students with topo-sheet as well as various GIS software used for demarcation and planning of CAD projects. Use of remote sensing techniques for command area development; case studies of some selected commands; Preparation of GIS-based CAD Plan for a selected command within the state of Assam.	**10**	**25**
IV	**Preparation of Command Area Development Plan:** Topographic survey and preparation of contour map; preparation of command area development layout plan; land levelling, design for a field; earthwork and cost estimation; irrigation water requirement of crops; preparation of irrigation schedules; planning and layout of water conveyance system; design of Irrigation systems; conjunctive water use planning; Technical Feasibility and economic viability of a command area project. Study tour to minor irrigation and command area development projects.	**15**	**25**
	Total	**45**	**100**

Text Books:

1. L. G. James, Principles of farm irrigation System design, 1988, John Wiley and Sons Ltd., Delhi
2. R. Lal, Irrigation Hydraulics, 1983, Saroj Prakasham, Allahabad

References:

1. V. V. N. Murthy, Land and Water Management Engineering, 6th Ed, 2013, Kalyani Publishers
2. B. D. Dhawan, Studies in Irrigation and Water Management, 1990, South Asia Books

Paper-II: Remote Sensing for Land & Water Resources	**Scheme of Evaluation: Theory**
Subject Code:CEE024C10W2	**Credits: L-T-P-C : 3-1-0-4** **Sem-I**

Prerequisites:

- Basic knowledge of electro-magnetism and some knowledge of photography and imaging

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Physics of remote sensing	Help students develop an understanding of Remote Sensing (RS)	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Understand the basic concepts of RS	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Platforms & remote sensing sensors	To teach about various platforms and Sensors used for RS data collection		Understand platforms and Sensors used for RS data collection	
III Digital image processing	To teach the techniques of image processing		Students will learn to process digital images	
IV Geographical Information System (GIS)	To teach GIS and how data can be analysed using GIS platforms		Students will learn to work on GIS platform	

Detailed Syllabus:

Modules	**Topics/course covered**	**Hrs.**	**Marks**
I	**Physics of remote sensing:** Electro-magnetic spectrum, atmospheric effects, energy interaction with earth surface features.	**10**	**25**
II	**Platforms & remote sensing sensors:** Photographic camera, scanners, earth resources satellites, active, passive microwave sensors.	**10**	**25**
III	**Digital image processing:** Image rectification, image enhancement, image classification and accuracy. Image interpretation.	**10**	**25**
IV	**Geographical Information System (GIS):** Map data representation, geographic database concepts and analysis. Application of remote sensing and GIS in land and water resources system and evaluation.	**15**	**25**
	Total	**45**	**100**

Text books:

1. B. Bhatta, Remote Sensing and GIS;2nd Edition, 2011, Oxford University Press, New Delhi
2. M. A. Reddy, Textbook of Remote Sensing & Geographical Information Systems, 3rd Edition, 2008, BS Publications, Hyderabad

References:

1. P. P. David and D. K. James, Aerial Photography and Image Interpretation; 2nd Edition, 2003, John Wiley and Sons Inc., New Delhi
2. A. M. Chandra, S. K. Ghosh, Remote Sensing and GIS, 2006, Alpha Science, New Delhi

Paper-III: Applied Hydrology	Scheme of Evaluation: Theory	Subject Code:CEE024C10W3
Credits: L-T-P-C : 3-1-0-4	Sem-I	

Prerequisites:

- Good command of Higher Secondary level physics
- Some knowledge of water cycle

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Introduction and Precipitation	Help students develop an understanding of hydrology and forms of precipitation	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will develop understanding of hydrology	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Evaporation and Subsurface Water	Understanding various abstractions including evaporation and sub-surface water		Quantify various surface and sub-surface water losses	
III Runoff Hydrology	Understanding various processes of watershed and runoff		Students will learn to calculate runoff	
IV Groundwater Hydrology	Learn various aspects of groundwater hydrology		Students will learn about ground water and its abstractions	

Detailed Syllabus:

Modules	Topics/Course content	Hrs.	Marks
I	**Introduction:** Hydrologic Cycle - the global phenomenon, the hydrologic model on a watershed scale, water balance, water resources and availability; History and scope of Hydrology; **Precipitation:** Earth's revolution, seasons, and atmospheric circulation; Formulation, types and distribution, Presentation and processing of data – Consistency and missing data, depth, area and duration; Mean rainfall-isohyetal and trend surface methods, confidence limits and comparison of averages; Frequency analysis – normal and lognormal distributions, frequency plotting, goodness of fit, climate classification, rain gauge network;	**15**	**25**
II	**Evaporation:** Methods of calculation – energy balance, aerodynamic methods; evapo-transpiration potential; Consumptive use, water requirement of crops; soil water balance and climate. **Subsurface Water:** Unsaturated flow, moisture flux, Infiltration rates, capacity, Measurement, Horton's and Philiph's equations; Green-Ampt method, Ponding time, surface runoff and infiltration indices.	**10**	**25**
III	**Runoff Hydrology:** Watershed processes; new concepts, surface runoff-Horton's flow, variable source area theory – subsurface flow – flow through matrix and pipes; Stream flow components hydrographs and separation; flow recession; unit hydrograph theory, derivation, S-curve and applications; travel time. Catchment response, factors influencing runoff.	**10**	**25**
IV	**Groundwater Hydrology**: Occurrence of groundwater. Vertical distribution of groundwater, zone of aeration, zone of saturation, types of aquifers, storage coefficient. Groundwater movement; Darcy's law, permeability, hydraulic conductivity, anisotropic aquifers, groundwater flow direction. Application of GIS for hydrological studies (introduction only)	**10**	**25**
	Total	**45**	**100**

Text book (s):

1. Raghunath H. M., Hydrology: Principles, Analysis & Design; Revised 2nd Edition, 2010, New Age International Publishers, New Delhi

2. K. C. Patra, Hydrology & Water Resources Engineering,2nd Edition, 2015, Narosa Publishing House, New Delhi

Reference (s):

1. V.T. Chow (ed.), Hand Book of Hydrology, 3rd Edition; 1988; McGraw Hill, New Delhi

2. K.N. Mutreja, Applied Hydrology, 2nd Edition; 1986; Tata McGraw Hill, New Delhi

Paper IV: Ground Water Development and Tube wells	**Scheme of Evaluation: Theory**
Subject Code: CEE024C10W4	**Credits: L-T-P-C : 3-1-0-4** **Sem-I**

Prerequisites:

- Basic knowledge of fluid mechanics and hydraulics
- Some knowledge of flow through porous media

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Occurrence and Movement of Ground Water and Well Hydraulics	Help students develop an understanding of wells and groundwater pumping	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will develop understanding of hydrology	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Ground Water Exploration	Understanding various abstractions including evaporation and sub-surface water		Quantify various surface and sub-surface water losses	
III Well Classification and Design	Understanding various processes of watershed and runoff		Students will learn to calculate runoff	
IV Tube-well Construction &Environmental impacts on groundwater: groundwater pollution	Learn various aspects of groundwater hydrology		Students will learn about ground water and its abstractions	

Detailed Syllabus:

Modules	Topics/Course content	Hrs.	Marks
I	**Occurrence and Movement of Ground Water:**Occurrence of Ground Water, Types of Water Bearing Formation and their Characteristics, Ground Water Movement and Darcy's Law, Aquifer Characteristics Influencing Ground Water Yield, Permeability and Factors Affecting Permeability, Measurement of Permeability **Well Hydraulics:** Classification of Wells, Steady State Flow in Fully Penetrating Wells, Unsteady State Flow in Fully penetrating Wells, Steady & Transient State Flow in Partially penetrating Wells, Interference of Wells, Pumping Test and Determination of Aquifer Parameters by: Theis Method, Copper-Jacob Method, Chow's Method	**15**	**25**
II	**Ground Water Exploration:** Objectives of Ground Water Exploration, Methods of Ground Water Exploration (Geological Method, Geophysical Method, Electrical Resistivity Method, Seismic Refraction Method, Water Winching	**10**	**25**
III	**Well Classification and Design:** Classification of Wells and Tube wells, Classification and Selection of Strainers, Design Considerations in Open Wells, Test Drilling, Design Consideration in Tubewells (Preparation of Bore Log, Grain Size Distribution of Water Bearing Strata, Determination of Safe Yield, Diameter and Depth of Casing Pipe, Diameter and Depth of Strainer, Design of Gravel Packing, Well Development, Multiple Well System	**10**	**25**
IV	**Tube-well Construction and Maintenance:** Methods of Drilling, Percussion Drilling, Hydraulic Rotary, Reverse Rotary, Bamboo shallow wells, Choice of Well Drilling Method, Installation of Well Casing and Screens **Environmental impacts on groundwater: groundwater pollution:** Temporal variation of groundwater, Stream flows groundwater levels, Evapo-transpirative and tidal fluctuations, Urbanization, Earthquakes, External loads, Land subsidence	**10**	**25**
	Total	**45**	**100**

Text book (s):

1. H.M. Raghunath, Ground Water,3rd Edition, 2007; New Age International, New Delhi
2. D. K. Todd, L. W. Mays, Groundwater Hydrology, 3rd Edition, 2011, John Wiley and Sons Ltd., Delhi

References:

1. K.R.Karanth,Ground Water Assessment, Development and Management, 1st Edition; 2001; Tata McGraw Hill Book Co.; New Delhi

2. A.M. Michael and S.D.Khepar;Water Wells and Pumps,2nd Edition; 2008; McGraw Hill Education (India) Private Limited; New Delhi

Paper-V: Climate Change and Water Resources	**Scheme of Evaluation: Theory**
Subject Code: CEE024C10W5	**Credits: L-T-P-C : 3-1-0-4** **Sem-I**

Prerequisites:

- Basic knowledge of climate and some knowledge of interaction between climatic parameters

<table>
<tr><th colspan="5">Facilitating Learning Outcome based Curriculum Framework (LOCF)</th></tr>
<tr><th>Module</th><th>Learning Objectives</th><th>Teaching Learning Process</th><th>Learning Outcomes</th><th>Course Evaluation</th></tr>
<tr><td>I
The Climate System</td><td>Help students develop an understanding of climate systems</td><td rowspan="4">1. Lectures
2. Assignments
3. Power Point
4. NPTEL Videos
5. Textbook</td><td>Students will develop understanding of climate</td><td rowspan="4">Semester End Examination : 70 Marks

Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)</td></tr>
<tr><td>II
(a) Impacts of Climate Change (Observed and Projected)
(b) Tools for Vulnerability Assessment</td><td>Understanding various impacts of climate change and tools used for vulnerability assessment</td><td>Quantify various impacts of climate change</td></tr>
<tr><td>III
Adaptation and Mitigation</td><td>Understanding various techniques of adaptation/mitigation</td><td>Students will learn to apply adaptation/ mitigation measures</td></tr>
<tr><td>IV
Case Studies</td><td>Study various case studies from around the world and the globe</td><td>Students will have overall knowledge</td></tr>
</table>

Modules	Topics/Course content	Hrs.	Marks
I	**The Climate System:** Definitions-Climate, Climate system, climate change –Drivers of Climate change –Characteristics of climate system components -Greenhouse effect –Carbon cycle –Wind systems -Trade Winds and the Hadley Cell –Ozone hole in the stratosphere -El Nino, La Nina–ENSO, Teleconnections	9	25
II	**Impacts of Climate Change (Observed and Projected):**Global Scenario –Indian Scenario –Observed changes and projected changes of IPCC -Impacts on water resources –NATCOM Report –Impacts on sectoral vulnerabilities –SRES –Different scenarios **Tools for Vulnerability Assessment:** Need for vulnerability assessment –Steps for assessment –Approaches for assessment –Models –Quantitative models, Economic model, Impact matrix approach -Box models -Zero-dimensional models -Radioactive-convective models -Higher-dimension models -EMICs (Earth-system models of intermediate complexity) -GCMs (global climate models or general circulation models) –Sectoral models	12	25
III	**Adaptation and Mitigation:** Water-related adaptation to climate change in the fields of Ecosystems and biodiversity, -Agriculture and food security, land use and forestry, Human health, water supply and sanitation, infrastructure and Economy (insurance, tourism, industry and transportation) -Adaptation, vulnerability and sustainable development Sector-specific mitigation -Carbon dioxide capture and storage (CCS), Bio-energy crops, Biomass electricity, Hydropower, Geothermal energy, Energy use in buildings, Land-use change and management, Cropland management, Afforestation and Reforestation -Potential water resource conflicts between adaptation and mitigation -Implications for policy and sustainable development.	**12**	**25**
IV	**Case Studies:** Water resources assessment case studies –Ganga Damodar Project, Himalayan glacier studies, Ganga valley project -Adaptation strategies in Assessment of water resources-Hydrological design practices and dam safety-Operation policies for water resources projects -Flood management strategies -Drought management strategies -Temporal & spatial assessment of water for Irrigation -Land use & cropping pattern -Coastal zone management strategies.	**12**	**25**
	Total	**45**	**100**

Text Books:

1. P. R. Shukla, S. K. Sarma, N. H. Ravindranath, Amit Garg and Sumana Bhattacharya,Climate Change and India: Vulnerability assessment and adaptation, Univ. Press (India)Pvt Ltd, Hyderabad.

2. IPCC Report Technical Paper VI –Climate change and water, 2008.

References:

1. UNFCC Technologies for Adaptation to climate change, 2006.

2. T. Younos, C. A.Grady, Climate Change and Water Resources, 1983, Springer-Verlag Berlin Heidelberg

3. Preliminary consolidated Report on Effect of climate change on Water Resources, CWC, MoWR, 2008.

4. U-Tube Lectures

Paper-VI: Research Methodology & Scheme of Evaluation: Theory
Intellectual Property Right
Subject Code: CEE024C10W6 **Credits: L-T-P-C: 2-0-0-2** **Sem-I**

Prerequisites:

- Basic knowledge of idea generation and project formulation

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Research Problems	Help students develop an understanding of research problems	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will know to frame research problems	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Literature Study and Technical Writing	Understanding the importance of literature study and aspects of technical writing		Students will be able to write technical papers	
III Nature of Intellectual Property	Understanding various rights related to Intellectual Property		Students will learn the rights of IP	
IV Patent Rights	Understanding various rights related to patents		Students will learn the rights related to patents	

Module	Content	Hrs	Marks
I	**Research Problems:** Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	**5**	**25**
II	**Literature Study and Technical Writing:** Effective literature studies approaches, analysis of Plagiarism, Research ethics Effective technical writing, how to write report and paper Developing a Research Proposal Format of research proposal, a presentation and assessment by a review committee	**3** **4**	**25**
III	**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of Patenting and Development: Technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**6**	**25**
IV	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**2** **4**	**25**
	Total	**24**	**100**

Text Book:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 2nd Edition, 2005, Pearson Publications

2. Stuart Melville and Wayne Goddard, Research methodology: an introduction for science & engineering students, 1996, Juta & Co. Ltd. South Africa

References:

3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction,2nd Edition, 2004, Juta & Co. Ltd., South Africa

Paper VII: Hydrology& Water Resources Engineering Lab	Scheme of Evaluation: P	
Subject Code: CEE024C11W7	**Credits: L-T-P-C : 0-0-2-1**	**Sem-I**

Prerequisites:

- Good knowledge of Higher Secondary level physics and some knowledge of water cycle

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Watershed delineation and characterisation	To understand tools/ techniques used for watershed delineation	1. Lab Experiments	Students will learn techniques of watershed delineation	Skill Test, Viva, Involvement in Lab Classes, Quiz, Class Test : 10 marks Lab Copy Submission : 02 marks Attendance : 03 marks Final Lab Examination : 35 marks
II Design of Rain gauge network	To understand how to establish rain gauge stations in an area		Learn the techniques used for watershed delineation	
III Measurement and analysis of hydrologic data (Precipitation, stream flow, evaporation and transpiration)	To understand how to measure and analyse various hydrologic data		Students will learn to measure and analyse various hydrologic data	
IV Water characteristics and quality determination	Determination of various chemical properties of water		Students will learn to find chemical properties of water	
V Measurement of flow in pressure conduits	Understand pressure variation in a conduit		Students will learn to findpressure variation	
VI Sediment yield and Stream flow simulation	Estimation of sediment yield		Students will know to estimate sediment yield	
VII Statistical techniques for analysis of random variables	Analysis of random variables		Students will learn to analyse random variables	

Hydrology& Water Resources Engineering Lab		
Labs	**Topics / Course content**	**Periods**
I	Watershed delineation and characterisation	As required
II	Design of Rain gauge network	
III	Measurement and analysis of hydrologic data (Precipitation, stream flow, evaporation and transpiration)	
IV	Water characteristics and quality determination	
V	Measurement of flow in pressure conduits	
VI	Sediment yield and Stream flow simulation	
VII	Statistical techniques for analysis of random variables	
VIII	Application of GIS in watershed planning	
	Total	

Text book (s):

3. Raghunath H. M., Hydrology: Principles, Analysis & Design; Revised 2nd Edition, 2010, New Age International Publishers, New Delhi

4. K. C. Patra, Hydrology & Water Resources Engineering,2nd Edition, 2015, Narosa Publishing House, New Delhi

Reference (s):

3. V.T. Chow (ed.), Hand Book of Hydrology, 3rd Edition; 1988; McGraw Hill, New Delhi

4. K.N. Mutreja, Applied Hydrology, 2nd Edition; 1986; Tata McGraw Hill, New Delhi

Paper VIII: GIS Lab		Scheme of Evaluation: P
Subject Code: CEE024C11W8	Credits: L-T-P-C : 0-0-2-1	Sem-I

Prerequisites:

- Basic knowledge of geography and some knowledge of remote sensing

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Creation of Maps	To understand tools/ techniques used for map creation	1. Lab Experiments	Students will learn techniques of map creation	Skill Test, Viva, Involvement in Lab Classes, Quiz, Class Test : 10 marks Lab Copy Submission : 02 marks Attendance : 03 marks Final Lab Examination : 35 marks
II Image Processing	To understand how to process images		Students will Learn to process images	
III Thematic Maps	To understand how to generate thematic maps		Students will Learn to prepare thematic maps	
IV Watershed delineation	To understand how to delineate watersheds		Students will Learn to delineate watersheds	

Detailed Syllabus:

Modules	Topics / Course content	Hrs.
I	**Creation of Maps:** Creation of vector maps and raster maps through digitization and rasterisation	**2**
II	**Image Processing:** Processing of digital images (geometric correction, image enhancement, image classification)	**2**
III	**Thematic Maps:** Preparation of thematic maps (Land use/ land cover, road maps, drainage network map etc.) from satellite image of any region.	**3**
IV	**Watershed delineation:** Watershed delineation from drainage map and contour map of any region. Development of Digital Elevation Model (DEM) using any technique	**4**

Text/ Reference books:

1. B. Bhatta, Remote Sensing and GIS, 2nd Edition, 2011, Oxford University Press, New Delhi

2. M. A. Reddy, Textbook of Remote Sensing & Geographical Information Systems, 3rd Edition, 2008, BS Publications, Hyderabad

References:

1. P. Pine David and D Kiser James; *Aerial Photography and Image Interpretation;* 2nd Edition, 2003, John Wiley and Sons Inc., New Delhi

2. D. R. Maidment; Arc Hydro: GIS for Water Resources, 3rd Edition; 2002, ESRI Press, California, USA

Paper IX: Seminar-I	Scheme of Evaluation: Presentation
Subject Code:CEE024C13W9	Credits: L-T-P-C : 0-0-4-2 Sem-I

Prerequisites:

- Ability to comprehend and speak

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
Presentation	This course is meant to give students practice speaking in front of a scientific audience and to explore topics in detail.	Individual students will be asked to choose a topic in any field of Water Resources Engineering, preferably from outside the M. Tech. syllabus and give seminar on the topic for about thirty minutes. Also, they have to submit a brief report of their seminar talk. A committee consisting of at least two faculty members specialized on different fields of Water resources engineering will assess the presentation of the seminars and report and award marks to the students.	1: Identify current trends and topics of relevance in Water Resources Engineering 2: Develop the ability of data collection on a specific topic and documenting the relevant details in a given format 3: Develop skills of presentation for conveying subject matter to audience	

Paper-X: Communicative English-I	**Scheme of Evaluation: Theory**
Subject Code: CEN984A101	**Credits: L-T-P-C : 1-0-0-1** **Sem-I**

Prerequisites:

- Basic knowledge of writing in English and good knowledge of grammar and usage of technical terms

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Planning	To understand planning	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will understand planning	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Review of the Literature	To learn how to review literature		Students will learn how to review literature	
III Key skills	Learn key skills		Students will learn key skills	
IV Useful phrases	Learn phrases		Students will learn phrases	

Detailed Syllabus:

Modules	**Topics/Course content**	**Hrs.**	**Marks**
I	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	**3**	**25**
II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	**4**	**25**
III	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	**3**	**25**
IV	Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	**4**	**25**
		14	**100**

Text Book:

1. R. Goldbort, Writing for Science, 2006, Yale University Press (available on Google Books)
2. R. Day, How to Write and Publish a Scientific Paper, 2006, Cambridge University Press

References:

1. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
2. Adrian Wallwork, English for Writing Research Papers, 2011, Springer New York DordrechtHeidelberg London

Paper-XI: Behavioural Science-I Scheme of Evaluation: Theory		
Subject Code: BHS982A104	**Credits: L-T-P-C : 1-0-0-1**	**Sem-I**

Prerequisite: Nil

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Western Philosophy to present Behavioral Science	To acquaint with western philosophy	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will get acquainted with western philosophy	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Behavioral and Social Science Disciplines	To learn about various disciplines of social & behavioural science		Students will learn various disciplines of social & behavioural science	
III Modes and Methods	To learn about modes and methods		Students will learn about modes & methods	
IV Applications	To learn about application of behavioural science		Students will learn about application of behavioural science	

Detailed Syllabus:

Modules	**Topics/Course content**	**Hrs.**	**Marks**
I	**Western Philosophy to present Behavioral Science:** Brief history Sources of knowledge. The problem of reliable knowledge Dynamics of development in the behavioural and Social Sciences.	**3**	**25**
II	**Behavioral &Social Science Disciplines:** Understanding various behavioural and social science disciplines like Psychology, Sociology, Anthropology, Economics, Political Science, Geography, History and Statistics.	**3**	**25**
III	**Modes and Methods:**Experimentation Statistical control Statistically uncontrolled observation.	**3**	**25**
IV	**Applications:**Three fundamental features of basic research in Behavioural Sciences, Exploring examples of behavioural science research.	**3**	**25**
		12	**100**

Text Books:

1. Adams, R. M., Smelser, N. J. & Treiman, D. J., *Behavioral and social science research: A national resource (Part I)*,1982, Washington: National Academy Press.

Reference Books:

1. O'Grady, M. *An introduction to behavioural science*, 2001, Gill & Macmillan, London.

SYLLABUS (2nd SEMESTER)

SEM-II							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C20W1	Systems Analysis in Water Resources	3	1	0	4	4
2	CEE024C20W2	Sediment Transport	3	1	0	4	4
3	CEE024C20W3	Urban Water Resources Management	3	1	0	4	4
4	CEE024C20W4	Evaluation of Water Resources Projects	3	1	0	4	4
5	CEE024C20W5	Environmental Impact Assessment of Water Resource Projects	3	1	0	4	4
6	CEE024C23W6	Seminar-II	0	0	4	2	4
Departmental Specific Elective (DSE)							
7	CEE024D20W5	Elective-I	3	1	0	4	4
Ability Enhancement Elective Course (AEEC)							
8	CEE024S20W1	Disaster Management	2	0	0	2	2
Ability Enhancement Compulsory Course (AECC)							
9	CEN984A201	Communicative English-II	1	0	0	1	1
10	BHS982A204	Behavioural Science-II	1	0	0	1	1
		Total	**22**	**6**	**4**	**30**	**32**

Elective-I
On Farm Water Management
Mathematical Models in Hydrology

Paper I: Systems Analysis in Water Resources	Scheme of Evaluation: Theory
Subject Code:CEE024C20W1	Credits: L-T-P-C : 3-1-0-4 Sem-II

Prerequisite:

- Good knowledge of mathematics and knowledge of optimization is preferable

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I System Concepts Linear Programming	To understand concepts of linear programming	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will understand concepts of linear programming	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Dynamic Programming	To learn how to formulate dynamic programming		Students will learn how to formulate dynamic programming	
III Simulation	To learn the simulation techniques		Students will learn simulation techniques	
IV Advanced Optimization Techniques	To learn advanced Optimization Techniques		Students will learn advanced Optimization Techniques	

Detailed Syllabus:

Modules	Topics/Course content	Hrs.	Marks
I	**System Concepts:** Definition, classification, and characteristics of systems - Scope and steps in systems engineering - Need for systems approach to water resources and irrigation. **Linear Programming:** Introduction to operations research-Linear programming, problem formulation, graphical solution, solution by simplex method - Sensitivity analysis, application to design and operation of reservoir, single and multipurpose development plans - Case studies.	**15**	**25**
II	**Dynamic Programming:** Bellman's optimality criteria, problem formulation and solutions - Application to design and operation of reservoirs, Single and multipurpose reservoir development plans - Case studies.	**10**	**25**
III	**Simulation:** Basic principles and concepts - Random variant and random process - Monte Carlo techniques - Model development - Inputs and outputs - Single and multipurpose reservoir simulation models - Case studies.	**10**	**25**
IV	**Advanced Optimization Techniques:** Integer and parametric linear programming – Goal programming models with applications Discrete differential dynamic programming and incremental dynamic programming - Linear decision rule models with application – Stochastic dynamic programming models.	**10**	**25**
	Total	**45**	**100**

Text book (s):

1. Water Resources Systems Planning & Management- An Introduction to Methods, Models & Applications;Daniel P. Loucks and Eelco van Beek, 1st Edition; 2005; UNESCO, Paris

2. Gupta P.K and Man Mohan; Problems in Operations Research (Methods and Solutions); 7th Edition; 1995, Sultan Chand and Sons, New Delhi

References:

1. Hiller F.S. and Liebermann G.J.; *Operations Research*; 1st Edition, 1992, CBS Publications & distributions. New Delhi.

Paper II: Sediment Transport	Scheme of Evaluation: Theory	
Subject Code: CEE024C20W2	Credits: L-T-P-C : 3-1-0-4	Sem-II

Prerequisite:

- Basic knowledge of soil loss from land surface and knowledge of soil erosion is necessary

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Mechanisms	To understand the mechanisms involved in sediment transport	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will understand mechanisms of sediment transport	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Modes of Sediment Transport	To understand the various modes of sediment transport		Students will learn about various modes of sediment transport	
III The Theory of Sediment Entrainment	To understand the concepts of sediment entrainment		Students will understand the concepts of sediment entrainment	
IV Relationships	To understand the relation of channel shape, habit, and solid load with sediment transport		Students will learn relation of channel shape, habit, solid load with sediment transport	

Detailed Syllabus:

Modules	Topics/Course content	Hrs.	Marks
I	**Mechanisms:** Aeolian, Fluvial, Coastal, Glacial, Hillslope, Debris flow, Properties of Transport Materials, Sediment yield, Regimes of flow, Forms of bed roughness, Resistance to flow.	**10**	**25**
II	**Modes of Sediment Transport:** Dissolved Load, Suspended-Sediment Load (Wash, Intermittently-suspended or saltation load, Suspended-sediment rating curves, Typical suspended-sediment loads in BC rivers, Relation of sediment concentration to sediment load/discharge), Bed/Traction Load, Bed load equations, Shear stress, Sediment Deposition: Settleable Solids, Competence & Capacity-Case studies.	**13**	**25**
III	**The Theory of Sediment Entrainment:** Types of forces: Impelling forces, Inertial forces, The Shields entrainment function, Application of Critical Threshold conditions for sediment motion: Bedload Transport equation, Threshold (equilibrium Concept)	**11**	**25**
IV	**Relationships:** Relation of Channel Shape, Habit, and Solid Load, Reservoir sedimentation, Human Influence, Consequences of Sediment Transport and Deposition: Scour, Contaminated sediment, Sediment Sampling and Measuring Device	**11**	**25**
	Total	**45**	**100**

Text Books:

1. P. Reddy; A Textbook of Hydrology, 3rd Edition, 2011; Lakshmi Publication; New Delhi.
2. G. W. Hans; Hydraulics of Sediment Transport; 1st Ed; 1971; McGraw Hills, New York

References:

1. Bloom A., Geomorphology: A Systematic Analysis of Late Cenozoic Landforms; 3rd Edition; 2012; Prentice Hall, New Jersey

Paper III: Urban Water Resources Management	Scheme of Evaluation: Theory
Subject Code:CEE024C20W3	Credits: L-T-P-C : 3-1-0-4 Sem-II

Prerequisite:

- Knowledge of urban hydrology and basic knowledge of open channel flow

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Introduction &Planning concepts &system planning	To understand the concept of urban systems	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will understand concepts of system planning	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Review of Hydrologic and hydraulic principles	To understand basic hydrologic and hydraulic principles		Students will have knowledge of hydrologic and hydraulic principles	
III Control of storm water pollution	To learn techniques to control storm water pollution		Students will have knowledge to control storm water pollution	
IV Operation and maintenance of urban drainage systems and Kinematic wave theory approach	To learn about operation and maintenance of urban drainage systems and use of software		Students will have knowledge of operation and maintenance of urban drainage systems and use of software	

Detailed Syllabus:

Module	Topics/Course content	Hrs.	Marks
I	**Introduction to drainage problems in different climates:** Urbanisation- its effects and consequences for drainage, Interaction between urban and peri-urban areas, Process of urbanisation and influence on hydrologic cycle **Planning concepts and system planning**: Objectives of urban drainage and planning criteria, Drainage and system layout, Planning tools and data requirement, Drainage master plan, Examples for drainage structures	**15**	**25**
II	**Review of Hydrologic and hydraulic principles:** Urban hydrologic cycle, hydrologic principles, Rainfall analysis in Urban environment and design storm, Hydraulic principles, hydrodynamic principles **Urban Runoff computations:** Empirical, Time-area and unit hydrograph approaches **Design of drainage system elements:** Hydraulic fundamentals, infiltration and on-site detention of storm water, Design of sewerage and drainage channels, Design of appurtenances, Road drainage, Design of pumping stations	**10**	**25**
III	**Control of storm water pollution:** Pollution build-up & wash-off process w.r.t. to urban drainage, Source control in commercial and industrial complexes, Storage options – dry and wet ponds, Biological treatment of wastewater, Chemical treatment of storm water	**10**	**25**
IV	**Operation and maintenance of urban drainage systems:** Maintenance requirement for different structures, Maintenance planning, Cleaning of sewers and drains, Inventory of damages, Repair options **Urban drainage: Kinematic wave theory approach** Introduction to urban watershed software, Hydrologic Cistern, Water conservation and ecological aspects, Water harvesting	**10**	**25**
	Total	**45**	**100**

Text book (s):

1. Akan A. O. and R. J. Houghtalen,Urban Hydrology, Hydraulics and Storm Water Quality, 1st Edition; 2003; John Wiley and Sons, New Jersey.

2. K. C. Patra, Hydrology & Water Resources Engineering, 2nd Edition; 2015; Narosa Publishing House, New Delhi

References:

1. Chow V.T. (ed.), Hand Book of Hydrology, 3rd Edition; 1988; McGraw Hill, New Delhi

2. Mutreja, K.N., Applied Hydrology, 2nd Edition; 1986; Tata McGraw Hill, New Delhi

Paper IV: Evaluation of Water Resources Projects	Scheme of Evaluation: Theory
Subject Code: CEE024C20W4	Credits: L-T-P-C : 3-1-0-4 Sem-II

Prerequisite:

- Knowledge of project comparison and basic knowledge of evaluation of alternatives

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Principles	To understand principles of project evaluation	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will understand the principles of project evaluation	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Economic and Financial Analysis	To learn to carry out economic and financial analysis and their difference		Students will learn to carry out economic and financial analysis	
III Quantification Methods	To learn methods viz. BC ratio, IRR, EIRR for project evaluation		Students will be able to calculate BC ratio, IRR, EIRR	
IV Analysis	To learn sensitivity and risk analysis		Students will learn to perform sensitivity and risk analysis	

Detailed Syllabus:

Modules	Topics / Course content	Hrs	Marls
I	**Principles:** General principles of project evaluation Private and social cost and benefit of water resources projects	**10**	**25**
II	**Economic and Financial Analysis:** Distinction between economic and financial analysis, Fixed and variable cost	**10**	**25**
III	**Quantification Methods:** Benefit Cost (BC) ratio, Internal Rate of Return (IRR) Economic Internal Rate of Return (EIRR), Nature of cost & benefits	**15**	**25**
IV	**Analysis:** Sensitivity and risk analysis, Calculation of future/present values and annuities, Case studies	**10**	**25**
Total		**45**	**100**

Text Books:

1. M.G. Bos, M.A. Burton and D.J. Molden; Irrigation and Drainage Performance Assessment: Practical Guidelines, 1st Edition; 2005; CABI Publishing, Oxfordshire

2. R. Rai, V. P. Singh, A. Upadhyay, Planning and Evaluation of Irrigation Projects, 1st Edition, 2017, Academic Press, New Delhi

References:

1. J. Price Gittinger; Compounding and Discounting Tables for Project Analysis: With A Guide to their Applications; 2ndEdition; 1984; John Hopkins University Press; Baltimore & London

Paper V: Environmental Impact Assessment of Water Resource Projects		Scheme of Evaluation: Theory
Subject Code: CEE024C20W5	**Credits: L-T-P-C : 3-1-0-4**	**Sem-II**

Prerequisite: Nil

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Concept	To understand the concept of EIA	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will understand EIA	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Legislation	To understand the legislations in vogue in India pertaining to EIA		Students will have knowledge of various legislations	
III Prediction and assessment	To learn methods to predict impacts on land, water, air and ecology		Students will learn to predict impacts of water resources projects	
IV Evaluation of alternatives	To learn various alternatives and their evaluation		Students will learn about alternatives and their evaluation	

Detailed Syllabus:

Modules	Topics / Course content	Hrs	Marks
I	**Concept** Concept of environment and sustainable development. Environmental impact assessment (EIA) – definitions, terminology and overview. Evolution of EIA – major features of the National Environmental Policy Act and the Council on Environmental Quality guidelines. Role of the USEPA. Generalised EIA process flow chart of the UNEP. Evolution of EIA in India – major features of the EIA notification and its subsequent amendments, implementation of EIA in India.	**12**	**25**
II	**Legislation** Legislation in India pertaining to environmental pollution and waste management. Steps in EIA such as screening, initial environmental examination (IEE), scoping, public participation. Environmental baseline studies. Impact assessment methods such as ad-hoc methods, checklists, matrices, quantitative methods, environmental indices, networks, overlay etc. Factors to be considered while assessing the environmental impacts of various infrastructure projects.	**13**	**25**
III	**Prediction and assessment** Prediction and assessment of impacts on land and soil, groundwater, surface water, air, noise, biological, socio-economic and visual environments (including details of various tools that can be employed for prediction of impacts). Guidelines published by the MoEF & CC regarding EIA of specific projects.	**10**	**25**
IV	**Evaluation of alternatives** Preparing the EIA document/ report, Environmental impact statement (EIS). Strategic environmental impact assessment. Environmental monitoring. Environmental audit (EA). Case studies.	**10**	**25**
Total		**45**	**100**

Text Books:

1. L. W. Canter, Environmental Impact Assessment, McGraw Hill, Inc., 1996.

2. Betty Bowers Marriot, Environmental Impact Assessment: A Practical Guide, McGraw Hill, Inc., 1997.

References:

1. UNEP, Environmental Impact Assessment Training Resource Manual, 2002

2. Guidelines for EIA published by the Ministry of Environment, Forests, and Climate Change (MoEF& CC), Government of India, 2006

Paper VI Seminar-II	Scheme of Evaluation: Presentation	
Subject Code:CEE024C23W6	Credits: L-T-P-C : 0-0-4-2	Sem-II

Prerequisite: Ability to comprehend and speak

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
Presentation	This course is meant to give students practice speaking in front of a scientific audience and to explore topics in detail.	Individual students will be asked to choose a topic in any field of Water Resources Engineering, preferably from outside the M. Tech. syllabus and give seminar on the topic for about thirty minutes. Also, they have to submit a brief report of their seminar talk. A committee consisting of at least two faculty members specialized on different fields of Water resources engineering will assess the presentation of the seminars and report and award marks to the students.	1: Identify current trends and topics of relevance in Water Resources Engineering 2: Develop the ability of data collection on a specific topic and documenting the relevant details in a given format 3: Develop skills of presentation for conveying subject matter to audience	

Paper VII: Elective-I Mathematical Models in Hydrology	Scheme of Evaluation: Theory
Subject Code: CEE024D20W5	Credits: L-T-P-C : 3-1-0-4 Sem-II

Prerequisite:

- Basic knowledge of hydrology

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Introduction	To learn about the problems in hydrology	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will To learn about the nature of problems in hydrology	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Linear systems	To learn theory, response functions of linear systems		Develop and solve rainfall-runoff models	
III Models	To have knowledge of models used in hydrology		Formulate& solve flood routing models for linear& nonlinear hydrologic systems	
IV Simulation Models	To learn simulation models		Classify forecasting and prediction problems in hydrology	

Detailed Syllabus:

Mod	Topics / Course content	Hrs.	Marks
I	**Introduction:** Nature of problems in hydrology, physical &systems approach, systems view of hydrologic cycle, hydrologic continuity equation	**8**	**25**
II	**Linear systems:** Theory, response functions of linear systems, lumped &distributed catchment systems, response function of hydrologic systems for discrete & continuous inputs, derivation of UH	**10**	**25**
III	**Models:** Linear conceptual models, linear reservoir & linear channel, Nash, Clarke and Dooge models, derivation of non-parametric unit hydrograph, derivation of synthetic unit hydrograph Flood routing, hydraulic & hydrologic flood routing, linear, kinematic wave and dynamic wave routing models, parameter estimation of flood routing models	**12**	**25**
IV	**Simulation Models:** Hydrologic simulation models, modeling of various hydrologic processes, overview of standard hydrologic simulation models	**15**	**25**
	Total	**45**	**100**

Text Book (s):

1. Chow, V.T., Maidment, D.R., and Mays, L.W., Applied Hydrology, McGraw Hill Inc. New York, 2010
2. Singh, V.P., Hydrologic Systems, Prentice Hall Inc., N York, 1986

References:

1. Kohnová, S., Szolgay, J. - Solín, Ľ. - Hlavčová, K.: Regional Methods for Prediction in Ungauged Basins. Key Publishing, Ostrava, 2006, 113 S., ISBN 80-87071-02-6.

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Paper VII: Elective-I (On Farm Water Management)Scheme of Evaluation: Theory		
Subject Code: CEE024D20W5	**Credits: L-T-P-C : 3-1-0-4**	**Sem-II**

Prerequisite:

- Knowledge of open channel flow and basic knowledge of irrigation efficiency

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Irrigation Systems and Water Management in India	To understand various irrigation systems	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will gain knowledge of various irrigation systems	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Canal Irrigation Management and Farm Water Delivery System and Control	To learn about flow irrigation, farm water delivery and control system		Students will gain knowledge of flow irrigation, farm water delivery	
III Irrigation Requirements and Scheduling	To gain knowledge of irrigation requirements and scheduling		Students will be able to estimate irrigation requirement and scheduling	
IV Waterlogging, Salinisation & Lining of Distribution System	To understand problems of waterlogging, salinization and basics of lining		Students will be able to handle problems of water logging and salinization	

Detailed Syllabus:

Modules	Topics / Course content	Hrs.	Marks
I	**Irrigation Systems and Water Management in India:** Utilizablewater resources of India, water demand for irrigation & other purposes, water balance, significance of irrigation in India, classification of irrigation systems, irrigation potential & expansion, water allocation & distribution practices, irrigation management organizations, water management in India, national water policy, concept of sustainable development, its criteria, sustainable water use.	**8**	**25**
II	**Canal Irrigation Management:**Irrigation systems layout, need for canal irrigation management, causes of poor performance of irrigation systems, strategies for improving canal irrigation management, new concepts of irrigation management, irrigation efficiencies, canal outlets & their suitability, criteria for analyzing behavior of outlets, canal regulation, performance evaluation of irrigation systems. **Farm Water Delivery System and Control:** Design of channels and underground pipelines, water regulating and diversion structures.	**10**	**25**
III	**Irrigation Requirements &Scheduling:** Evapotranspiration, direct measurement and estimation of ET, effective rainfall, irrigation scheduling, scheduling strategies, crop production functions. **Waterlogging, Salinisation & Lining of Distribution System:**Effects & causes of waterlogging, salinisation process & damage, average root zone salinity, use of marginal & poor quality water, salt balance, regional salt balance, remedial measures, conjunctive use of surface & groundwater, canal losses, lining of irrigation channels, types of lining, design of lined canal, economics of canal lining.	**12**	**25**
IV	**Farm Irrigation System Design:** Types, application methods and design, performance evaluation of farm irrigation system. **Micro Irrigation Systems:** Micro systems versus surface irrigation systems, types of sprinklers, principles of sprinkler operation, uniformity coefficient, economic design of a sprinkler system, system design efficiency, trickle irrigation systems, control head, trickle system components, water distribution in the soil profile, trickle system design, fertigation, irrigation automation. **Drainage of Irrigated Land:** Drainage problems, sources of excess water, drainage systems&requirements, planning & design of drainage systems, design of pipe drainage systems, well drainage, mole drainage, cost evaluation of drainage projects.	**15**	**25**
	Total	**45**	**100**

Text Book (s):

1. Rakesh Hooja;Management of Water for Agriculture: Irrigation, Watersheds and Drainage;1st Edition; 2006, Rawat Publications, New Delhi

2. J.W.Kijne, R.Barker, and D.Molden; Water Productivity in Agriculture: Limits and Opportunities for Improvement; 1st Edition, 2003, CABI Publishing, Wallingford, U.K.

References:

1. M. Giodanoand K.G.Villbolth; The Agricultural Ground Water Revolution Opportunities and Threats to Development; CABI Publishing, Walling ford, U.K., 2007

Paper VIII: Disaster Management		Scheme of Evaluation: Theory
Subject Code: CEE024S20W1	Credits: L-T-P-C : 2-0-0-2	Sem-II

Prerequisites:

- Basic knowledge of natural disasters and their types

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Introduction	To introduce the subject to students	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will learn the basics	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Repercussions of Disasters and Hazards	To understand the implications of natural disasters		Students will learn about the effects of disasters	
III Disaster Preparedness and Management	To gain knowledge of disaster preparedness and management		Students will learn about ways to prepare for disasters	
IV Risk Assessment and Disaster Mitigation	To learn about risk assessment and disaster mitigation		Students will be able to assess disaster risk	

Module	Content	Hrs	Marks
I	**Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude. **Disaster Prone Areas In India:** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics	2 2	25
II	**Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	3	25
III	**Disaster Preparedness And Management:** Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.	4	25
IV	**Risk Assessment:** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. **Disaster Mitigation:** Meaning, Concept And Strategies of Disaster Mitigation, EmergingTrends In Mitigation. Structural Mitigation and Non-StructuralMitigation, Programs of Disaster Mitigation In India.	3 2	25
	Total	**16**	**100**

Text Book:

1. R. Nishith, A. K. Singh, Disaster Management in India: Perspectives, issues and strategies. New Royal Book Company, New Delhi.

2. Sahni, Pardeep et. al. (Eds.), Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.

References:

1. Goel S. L., Disaster Administration and Management: Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Paper IX: Communicative English-II		**Scheme of Evaluation: Theory**
Subject Code: CEN984A201	**Credits: L-T-P-C : 1-0-0-1**	**Sem-II**

Paper X: Behavioural Science-IIScheme of Evaluation: Theory
Subject Code: BHS982A204Credits: L-T-P-C : 1-0-0-1Sem-II

Prerequisites: Nil

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching LearningProcess**	**Learning Outcomes**	**Course Evaluation**
I Self and Identity	To have insight into self & identity	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will learn about self	Semester End Exam: 70 Marks Internal Assess-ment: 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Exam: 10 Marks, Attendance: 05 Marks)
II Structure and Functions of Identity	To learn about structure and functions of identity		Students will learn about structure and functions of identity	
III Social Perception	To have idea on social perception		Students will have idea on perception	
IV Attribution	To have idea about attribution		Students will have idea of attribution	

Modules	**Topics/Course content**	**Hrs.**	**Marks**
I	**Self and Identity:**Separated and Connected perspective Immersed and Distal perspective Self-concept, self-esteem and self-efficacy Personal and social identity	**3**	**25**
II	**Structure and Functions of Identity:** Continuity and differentiation Identity crisis: Erikson and Marcia Quarterlife crisis- a new concept of understanding young people's difficulties in transitioning to adulthood	**3**	**25**
III	**Social Perception:**Making sense and categorizing information from environment Person schemas and group stereotypes	**3**	**25**
IV	**Attribution:**Attribution theory,dispositional versus situational attributions, Inferring dispositions from acts, Co-variation model of attribution, Attributions for success and failure, Bias and error in attribution, Over-attribution to dispositions, Focus of attention bias, Actor observer difference, Motivational biases, Cultural basis of attributions	**3**	**25**
	TOTAL	12	100

Text Books:

1. Baron, R. A.& Branscombe, N. R.,*Social Psychology*, 13th Edition, 2012, US Pearson.

2. Baumeister, R. F., *Self-concept, self-esteem and identity*., 1999 In Varerian, J. D., Barbara, W. A. & Warren, J. H. (Eds*), Personality: Contemporary Theory and Ethnicity,* (pp. 339-375). US: Nelson-Hall Publishers

Reference Books:

1. Leary, M.R. & Tangney, J. P., Handbook of Self &Identity, 2012, New York: The Guilford Press.

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SYLLABUS (3rdSEMESTER)

SEM-III							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C30W1	Watershed Conservation and Management	3	1	0	4	4
2	CEE024C30W5	Dissertation (Phase-I) and Presentation	0	0	24	12	24
3	CEE024C30W6	Summer Training Report (Undertaken at the end of Sem-II)	0	0	0	1	0
Departmental Specific Elective (DSE)							
4	CEE024D30W1	Elective-II	3	1	0	4	4
Ability Enhancement Elective Course (AEEC)							
5	CEE024S30W1	Forensic, Rehabilitation and Structural Health Monitoring	2	0	0	2	2
Ability Enhancement Compulsory Course (AECC)							
6	CEN982A301	Communicative English-III	1	0	0	1	1
		Total	**8**	**2**	**24**	**24**	**35**

Elective-II
Design of Drainage Systems
Water Resources Planning & Management

Paper-I: Watershed Conservation and Management	Scheme of Evaluation: Theory
Subject Code: CEE024C30W1Credits: L-T-P-C: 3-1-0-4	Sem-III

Prerequisites:

- Basic knowledge of soil erosion, hydrology, water quality, drought, rainwater harvesting

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Watershed Concepts	To learn about concepts of watershed and its development	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will learn the basics of watershed	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Soil Conservation Measures	To learn about soil conservation measures adopted in a watershed		Students will learn soil conservation measures	
III Water Harvesting and Conservation	To learn about water harvesting structures to be constructed in a watershed		Students will learn about water harvesting structures	
IV Watershed Management	To prepare watershed manage-ment plans & their implementation		Students will learn to prepare WM Plans	

Detailed Syllabus:

Modules	Topics & Course Content	Hrs.	Marks
I	**Watershed Concepts:** Watershed -Need for an Integrated Approach-Influencing Factors: Geology-Soil –Morphological Characteristics -Toposheet -Delineation –Codification –Prioritization of Watershed –Indian Scenario	10	25
II	**Soil Conservation Measures:** Erosion types–Water & Wind Erosion: Causes, Factors, Effects and Control –Soil Conservation Measures: Agronomical and Mechanical -Estimation of Soil Loss -Sedimentation	10	25
III	**Water Harvesting and Conservation:** Water Harvesting Techniques –Micro-Catchments-Design of Small Water Harvesting Structures –Farm Ponds –Percolation Tanks –Yield from a Catchment	10	25
IV	**Watershed Management:** Project Formulation-Watershed Develop-ment Plan-Entry Point Activities-Estimation-Watershed Economics-Agroforestry-Grassland and Wasteland Management-Watershed Approach in Government Programmes-Developing Collaborative know how- People's Participation-Evaluation of Watershed projects **GIS for Watershed Management:** Applications of RS and GIS-Role of Decision Support System-Conceptual Models & Case Studies	15	25
	Total	**45**	**100**

Text Book (s):

1.G. Das, Hydrology and Soil Conservation engineering, 2000, Prentice Hall, New Delhi

2.R. V. Singh, Watershed Planning &Management,1st Ed., 2000, Yash Publishing House, Bikaner

References:

1. Glenn O. Schwab, Soil and Water Conservation Engineering, 1981, John Wiley and Sons, Delhi

2. Gurmail Singh, A Manual on Soil and Water Conservation, 1982, ICAR Publication, NewDelhi

Paper-II: Dissertation (Phase-I)& Presentation		Scheme of Evaluation: Presentation
Subject Code: CEE024C30W5	Credits: L-T-P-C: 0-0-24-12	Sem-III

Syllabus Contents:

Dissertation-I will have end semester presentation. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions and must bring out individual's contribution. Continuous assessment of Dissertation-I at Mid Sem and End Sem will be monitored by the departmental committee.

Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
i) Identify water resources related problems by reviewing available literature. ii) Identify methods/ techniques to analyze water resources systems/ problems. iii) Apply engineering and management principles and bring forth solutions	i) Each topic to be expounded with adequate examples. ii) Discussions and question-answer rounds are encouraged iii) Theoretical problems solving needed to grasp the underlying concepts iv) Students have to go through case studies to understand field problems v) Students to be encouraged to give short presentations.	(i) Continuous Evaluation-30 marks (a)10 marks on literature review (b) 15 marks on presentation (c) 05 marks on attendance (c) End-term presentation: 70 marks

Paper-III: Summer Training Report		Scheme of Evaluation: Presentation
Subject Code: CEE024C30W6	Credit: L-T-P-C : 0-0-0-1	Sem-III

Content:

The students will mandatorily undertake Summer Training during the summer break (at the end of Sem-II) in an area/topic having relevance to the course programme. This shall be decided preferably by the Dissertation Guide under whom the student will work for his/her Dissertation (Phase-I) during the Sem-III. The course being a credit course, the students shall prepare a Training Report and submit to the Head of the Department through their Research Guide/Supervisor. Further, the report shall be presented during the departmental seminar before the faculty members of the department at the beginning of the Sem-III. The final training report (after due corrections, if any) shall be submitted to the departmental library.

Evaluation Pattern:

- Presentation before faculty members : 50%
- Submission of report : 50%

Paper-IV: Elective-II (Design of Drainage System)	**Scheme of Evaluation: Theory**	
Subject Code: CEE024D30W1	**Credits: L-T-P-C: 3-1-0-4**	**Sem-III**

Prerequisites:

- Basic knowledge of soil types, permeability and flow through porous media

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Basics of Drainage	To learn about basics of drainage	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will learn principles of drainage engineering	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Surface Drainage System	To learn about surface drainage systems		Students will learn design of surface drainage system	
III Sub-surface Drainage System	To learn about sub-surface drainage systems		Students will learn design of sub-surface drainage system	
IV Drainage Materials	To gain knowledge of materials used in drainage		Students will learn selection and use of drainage materials	

Mod	Chapter/Topic	No. of Lectures	Marks
1	**Basics of Drainage**: Objectives of drainage, Need of drainage, purpose of drainage, Effect of poor drainage, benefits of drainage, Drainage requirement of various crops, Interrelationship of irrigation and drainage, Subsurface Drainage: Drainage properties-structure and texture, Drainable porosity, Hydraulic conductivity	10	25
2	**Surface Drainage System:** Introduction, Components of Surface Drainage System (Land Forming, Field Drains and Field Laterals), Design Consideration for Land Grading, Land Grading Calculation (Plane Method, Profile Method), Design Consideration for Field Drains and Field Laterals (Design Consideration for Field Drains, Design Consideration for Field Laterals, Layout and Design of Field Drains and Laterals), Maintenance of Surface Drainage System	10	25
3	**Sub-surface Drainage System** Introduction, general considerations, Components of Subsurface drainage system and different layouts of Subsurface drainage system, Hydraulic design of subsurface system **Equations for Drainage Spacing& Criteria** Derivation of ellipse (Hooghoudt's Equn), Ernst's drain spacing equations. Unsteady state equation (Glover-Dum), Dynamic equilibrium concept, Drainage criteria for steady & unsteady state, Design of subsurface drainage system-problems	12	25
4	**Drainage Materials:** Drainage materials: Drainage pipes, drain envelop and drainage structures, Design of gravel envelope, Installation of subsurface drainage system, Procedure, Mole drainage, Bio-drainage, Vertical/Well drainage,	13	25
	Total	**45**	**100**

Text book:

1. U.S.Kadam, R.T.Thokal, Sunil Gorantiwar, A.G. Powar, Agricultural Drainage: Principles & Practices, 1stEdition, 2008, Westville Publishing House, New Delhi

2. J.N.Luthin, Drainage Engineering, 1st Edition, 1970, Wiley Eastern Pvt. Ltd., New Delhi

References:

1. Drainage Principles and Application - ILRI Publications, Netherlands Vol. 2 (E-book)

2. Drainage Principles and Application - ILRI Publications, Netherlands Vol. 4 (E-book)

Paper-IV: Elective-II		**Scheme of Evaluation: Theory**
(Water Resources Planning & Management)		
Subject Code: CEE024D30W1	**Credits: L-T-P-C: 3-1-0-4**	**Sem-III**

Prerequisites: Basic knowledge of hydrology and planning

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Historical profile	Learn about historical development of water resources and utilization	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will learn about historical development and utilization of water resources	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Watershed management	Learn to manage water resources within a watershed		Students will learn to plan and manage water resources within a watershed	
III Water resource planning	Learn to plan and utilize water resources within a basin/watershed		Students will learn planning and allocation of water within a given boundary/area	
IV Global Efforts on Water conservation	To gain knowledge about global efforts being put in conserving water		Students will gain knowledge about global efforts being put in water conservation	

Mod	Chapter/Topic	No. of Lectures	Marks
1	**Historical profile:** Global water resources, Hydrologic cycle, Watershed zoning, Interrelation of water resources with other natural resources and the environment, Water quantity and water budget, Water allocation and water scheduling;	10	25
2	**Watershed management:** Rainfall-Runoff analysis, Floods measurement, frequency analysis, design of peak flood and routing, Reservoir operation and design; Water resources availability and demand, Water use sectors – Domestic, Industries and Agriculture, Sustainable water resources development, Integrated Water Resources Management (IWRM), Socio-economic aspects of water resources management, Rainwater Harvesting;	10	25
3	**Water resource planning:** concept, preliminary study, feasibility study, detailed planning, Design of water distribution system, Irrigation scheduling and techniques; Hydrologic Processes – evaporation, transpiration and precipitation; Water quality parameters, Water pollution – causes, effects and measures;	12	25
4	**Global Efforts on Water conservation:** Think Globally Act Locally on water resources, Local water organizations, National Water Policy, World water organizations - WUGs, WUAs, UN, WWP, WWC, etc. Environmental discourse on dam Construction	13	25
	Total	**45**	**100**

Text book:

1. Water Resources Systems Planning and Management, Vol. 51 by Jain, S.K. and V.P. Singh, Elsevier Science.

2. Global Water Partnership (GWP), Integrated Water Resources Management, Background Papers No. 4, Technical Advisory Committee (TAC).

References:

1. Water Resources Systems Planning and Management, Vol. 51 by Jain, S.K. and V.P. Singh, Elsevier Science

2. Water Resources Systems Planning and Analysis by Loucks, D.P., J.R. Stedinger, and D.A. Haith, Prentice-Hall, N.J

Paper-V: Forensic, Rehabilitation and Structural Health Monitoring	**Scheme of Evaluation: Theory**
Subject Code: CEE024S30W1 Credit: L-T-P-C :2-0-0-2	**Sem-III**

Prerequisites:

- Basic knowledge of structures/buildings

Facilitating Learning Outcome based Curriculum Framework (LOCF)				
Module	**Learning Objectives**	**Teaching Learning Process**	**Learning Outcomes**	**Course Evaluation**
I Forensics in Engineering	To learn scope of Forensics in Engineering	1. Lectures 2. Assignments 3. Power Point 4. NPTEL Videos 5. Textbook	Students will learnbasics of forensics in engineering	Semester End Examination : 70 Marks Internal Assessment : 30 Marks (Assignments, Presentation:15 Marks, Mid-Term Examination: 10 Marks, Attendance: 05 Marks)
II Failure of Structures	To learn about various causes of structural failure		Students will learn about various causes of structural failure	
III Modern Techniques of Retrofitting	To learn about retrofitting, repairs and restoration of structures		Students will learn about retrofitting, repairs & restoration of structures	
IV Structural Health Monitoring	To learn applications of sensors in structural health monitoring		Students will learn applications of sensors in structural health monitoring	

Detailed Syllabus:

Module	Content	Hrs	Marks
I	**Forensics in Engineering:** Definition of Forensic, Importance of Forensic in Civil Engineering, Role and duties of Forensic engineers	**10**	**25**
II	**Failure of Structures:** Types of failure, review of the construction theory, performance problems, caused of distress in structural members, design and material deficiencies over loading. **Environmental Problems and Natural Hazards**: Pollution and carbonation problems, durability of RCC structures, damage due to earthquake and flood, strengthening of buildings**.**	**11**	**25**
III	**Modern Techniques of Retrofitting:** Introduction, types- Guniting, jacketing, use of chemicals in repair, applications of polymers, ferrocement and fiber concretes as rehabilitation materials, foamed concrete, mortor repair for cracks, shoring and under pinning, strengthening by pre-stressing,	**13**	**25**
IV	**Structural Health Monitoring:** Introduction, Different systems in SHM, Objectives, Advantages, Types of SHM, Components, Instrumentations used in SHM; Types of Sensors and its characteristics in health monitoring, Diagnostic techniques- vibration signature analysis, neural network-based classification techniques.	**11**	**25**
	TOTAL	**45**	**100**

Text Book:

1. Health Monitoring of Structural Materials and Components- Methods with Applications, Douglas E. Adams, John Wiley & Sons Ltd., 2007.

2. Structural Health Monitoring of Civil Infrastructure Systems, Vistasp M.Karbhari and Farhad Ansari, Woodhead Publishing Limited, Oxford Cambridge, New Delhi, 2009.

References:

1. Applications of metaheuristic Optimization Algorithms in Civil Engineering, A.Kaveh, Springer Publications.

Paper-VI: Communicative English-III	**Scheme of Evaluation: Theory**
Subject Code: CEN982A301 **Credit: L-T-P-C :** 1-0-0-1 **Sem-III**	

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SYLLABUS (4thSEMESTER)

SEM-IV							
Sl. No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Courses (CC)							
1	CEE024C43W2	Dissertation (Phase-II) and Presentation	0	0	36	18	36
2	CEE024C43W3	Publication of Technical Paper	0	0	0	1	0
Ability Enhancement Compulsory Course (AECC)							
3	CEN984A401	Communicative English-IV	1	0	0	1	1
		Total	**1**	**0**	**36**	**20**	**37**

Paper-I: Dissertation (Phase-II)& Presentation		Scheme of Evaluation: Presentation
Subject Code: CEE024C43W2	Credits: L-T-P-C: 0-0-36-18	Sem-IV

Syllabus Contents:

Dissertation-II will be extension of the work on the topic identified in Dissertation-I. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc. There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with the guide.

Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
i) Identify water resources related problems by reviewing available literature. ii) Identify methods/ techniques to analyze water resources systems/ problems. iii) Apply engineering & management principles and bring forth solutions related to water resources	i) Each topic to be expounded with adequate examples. ii) Discussions and question-answer rounds are encouraged iii) Theoretical problems solving needed to grasp the underlying concepts iv) Students have to go through case studies to understand field problems v) Students to be encouraged to give short presentations.	(i) Continuous Evaluation :30 marks (a)literature review: 10 marks (b) presentation:15 marks (c) attendance: 05 marks (ii) End-term presentation: 70 marks

Paper-II: Publication of Technical Paper	**Scheme of Evaluation: Presentation**
Subject Code: CEE024C43W3	**Credits: L-T-P-C: 0-0-0-1** **Sem-IV**

Syllabus Contents:

Each and every student under the programme has to get at least one (1) technical/research paper published in a reputed journal based on his/her thesis work carried out during Sem-III & Sem-IV. The paper has to be written following all standard norms/guidelines.

Paper-III: Communicative English-IV Scheme of Evaluation: Theory
Subject Code: CEN984A401 Credits: L-T-P-C: 1-0-0-1 Sem-IV