SYLLABUS

OF

M. TECH
(Environmental Engineering)

II YEAR

(CBCS)

DEPARTMENT OF CIVIL ENGINEERING

INTEGRAL UNIVERSITY LUCKNOW

STUDY AND EVALUATION SCHEME (Full Time)

M.Tech. (Environmental Engineering)

(w.e.f. 2021-22)

Semester – III

S. No.	Course Category	Code No	Name of Subject	Periods				Evaluation Scheme				Subject Total
				L	T	P	C	Continuous Assessment (CA)			Exam ESE	
								CT	TA	Total		
1	DE	As per Annexure	Departmental Elective - II	3	1	-	4	40	20	60	40	100
2	DE	As per Annexure	Departmental Elective - III	3	1	-	4	40	20	60	40	100
3	DE	As per Annexure	Departmental Elective - IV	3	1	-	4	40	20	60	40	100
4	DC	CE636	Directed Study	-	-	-	4	-	-	-	100	100
5	DC	CE699	M.Tech Dissertation	-	-	-	4	-	-	60	40	100
Total				**9**	**3**	**-**	**20**					**500**

Semester – IV

S. No.	Course Category	Code No	Name of Subject	Periods				Evaluation Scheme				Subject Total
				L	T	P	C	Continuous Assessment (CA)			Exam ESE	
								CT	TA	Total		
1	DC	CE699	M.Tech Dissertation	-	-	-	4	-	-	60	40	100
2	DC	CE699	M.Tech Dissertation	-	-	-	4	-	-	60	40	100
3	DC	CE699	M.Tech Dissertation	-	-	-	4	-	-	60	40	100
4	DC	CE699	M.Tech Dissertation	-	-	-	4	-	-	60	40	100
Total				**-**	**-**	**-**	**16**					**400**

L – Lecture; **T –** Tutorial; **P –** Practical; **C** – Credits; **CT** – Class Tests; **TA** – Teacher Assessment
Continuous Assessment (CA) = Class Tests + Teacher Assessment

Subject Total = Continuous Assessment (CA) + End Semester Examination (ESE)

DC – Departmental Core **DE** – Departmental Elective

Departmental Elective – II

CE621 Air and Water Quality Modeling
CE622 Ecological Engineering
CE623 Principles of Environmental Science

Departmental Elective – III

CE626 Fundamentals of Sustainable Development
CE627 Cleaner Production
CE628 Environmental Geotechnology

Departmental Elective – IV

CE631 Environmental Engineering Structures
CE632 Surface and Ground Water Modeling
CE633 Water Resources Systems Management

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CE621	**Title of the Course**	Air and Water Quality Modeling	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To educate the students on the basic principles, development and application of air and water quality models with computer applications.						

Course Outcomes	
CO1	Student will be able to explain the concept of Air Quality Modelling.
CO2	Student will be able to learn about principles of Flow Analysis.
CO3	Student will learn about concept of Water Quality Modelling.
CO4	Student will be able to understand Dispersion Of Air Pollutants.
CO5	Student will be able to understand the Software Modelling.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Air Quality Modelling	Model, definition, types, uses, systems and models, kinds of mathematical models, model development water quality standards - ambient air quality standards.	08	CO1
2	Flow Analysis	Historical development of water quality models, rivers and streams water quality modelling, river hydrology and flow, low flow analysis, dispersion and mixing, flow, depth, and velocity.	08	CO2
3	Water Quality Modelling	Estuaries - estuarine transport, - estuary dispersion coefficient; Lakes and impoundments - water quality response to inputs; water quality modelling process - model sensitivity - assessing model performance.	08	CO3
4	Dispersion Of Air Pollutants	Transport and dispersion of air pollutants - wind velocity, wind speed and turbulence; estimating concentrations from point sources - the Gaussian Equation - atmospheric stability - Air pollution modeling and prediction - Plume rise, modelling techniques.	08	CO4
5	Software Modelling	Exposure to computer models for surface water quality, and air quality.	08	CO5

Reference Books:

Water Supply Engineering: Environmental Engineering v. 1, S. K. Garg, 29th Edition, Khanna Publication, 2013.

Environmental Engineering, Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, 1st Edition 1985, McGraw Hill Education; Reprint 2013.

Gilbert M. Masters, Wendell P. Ela, Introduction to Environmental Engineering and Science, Prentice Hall, 3rd Edition, 2007.

K.V.S.G. Murali Krishna, Air Pollution and Control, Laxmi Publications, 1st Edition, 2017.

e-Learning Source:

https://www.hindawi.com/journals/tswj/2013/231768/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO2	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO3	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO4	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO5	3	0	0	0	0	0	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CE622	**Title of the Course**	Ecological Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To educate the students on the principles of ecology as applied to environmental engineering.						

Course Outcomes	
CO1	Student will be able to explain the concept of Ecology & Environment.
CO2	Student will be able to.learn about principles of ecological engineering.
CO3	Student will learn about concept of ecosystem
CO4	Student will be able to understand the application of ecological engineering
CO5	Student will be able to understand the basics of eco-modelling and case studies in ecological engineering

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Ecology & Environment	Aim, scope and applications of ecology - Development and evolution of ecosystems - Principles and concepts pertaining to communities in ecosystem - Energy flow and material cycling in ecosystems productivity in ecosystems - Rationale of ecological engineering and ecotechnology, Classification of ecotechnology.	08	CO1
2	Principles of Ecological Engineering	Principles, components and characteristics of Systems, Classification of systems, Structural and functional interactions of environmental systems, Environmental systems as energy systems - Mechanisms of steady state maintenance in open and closed systems.	08	CO2
3	Concept of Ecosystem	Components of sustainability, Complexity of growth and equity, International Summits, Conventions Agreements, Transboundary issues Action plan for implementing sustainable development – Moral obligations and Operational guidelines.	08	CO3
4	Application of Ecological Engineering	Ecosanitation, Principles and operation of soil infiltration systems, Wetlands and ponds - Source separation systems, Aquacultural systems - Detritus based treatment for solid wastes, Applications of ecological engineering for marine systems.	08	CO4
5	Eco-Modelling and Case Studies in Ecological Engineering	Modelling and ecotechnology, Elements of modelling, Modelling procedure, Classification of ecological models, Applications of models in ecotechnology, Ecological economics. Case studies of Integrated Ecological Engineering Systems and their commercial prospects.	08	CO5

Reference Books:

Patrick Kangas, Ecological Engineering: Principles and Practice, Lewis Publishers, New York. 1st Edition, 2003.

Etnier and Guterstam, “Ecological Engineering for Wastewater Treatment”, Lewis Publishers, New York. 1st Edition, 2007.

I.D White, D.N Mottershed, and S.J Harrison, “Environmental Systems - An Introductory Text”, Chapman Hall, London. 1st Edition 2004.

J.W. Mitsch and S.E Jorgensen, “Ecological Engineering - An Introduction to Ecotechnology”, John Wiley & Sons, New York. 1st Edition, 2009.

e-Learning Source:

https://www.journals.elsevier.com/ecological-engineering/

http://www.ecological-engineering.com/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO2	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO3	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO4	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO5	3	0	0	0	0	0	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CE623	**Title of the Course**	Principles of Environmental Science	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• Student will be able to understand the basics of physical science and chemical science. • Student will be able to understand the basics of Environmental Ecology. • Student will learn about different microorganism present in water and M.F techniques to control the problems caused by microorganism and algae. • Student will be able to understand the basics of different enzymic reactions and the basic Structure of the atmosphere.						

Course Outcomes	
CO1	Structure of Environment – interaction between biological and chemical components, Basics of hydrosphere, atmosphere, lithosphere, biosphere, scope and importance of environmental science..
CO2	Student will be able to explain the interaction between different species of the environment.
CO3	Student will learn about different microorganisms present in environment and their significance.
CO4	Student will be able to understand the basics of different enzymes reactions and the basic of aquatic chemistry.
CO5	Student will be able to understand the basics of atmospheric chemistry.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction of Environmental Science	Structure of Environment – interaction between biological and chemical components, Basics of hydrosphere, atmosphere, lithosphere, biosphere, scope and importance of environmental science.	08	CO1
2	Biological Systems	Plants Animals distribution, interaction, biomass classification, salient features, nutrients and microorganisms, environmental factors.	08	CO2
3	Microbiology of Environment	Microbiology of water – soil – air. Indicator organisms, - coliforms MPN index M.F.technique – Biological indices. Biomonitoring methods – Eutrophication. Biological treatment of wastewater – bacterial reductions.Algae in water supply systems – problems and control. Macrophytes in water bodies –role – control.	08	CO3
4	Chemistry of Aquatics	Common organic reactions, Enzymes and factors influencing enzymatic reactions, Pesticides and syndets Transformation and degradation of pollutants.	08	CO4
5	Atmospheric Chemistry	Structure of the atmosphere, Photochemistry of the atmosphere, ozone layer depletion, Acid rain, Greenhouse gases and global warming.	08	CO5

Reference Books:

Water Supply Engineering: Environmental Engineering v. 1, S. K. Garg, 29th Edition, Khanna Publication, 2013.

Environmental Engineering, Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, 1st Edition 1985, McGraw Hill Education; Reprint 2013.

Gilbert M. Masters, Wendell P. Ela, Introduction to Environmental Engineering and Science, Prentice Hall, 3rd Edition, 2007.

K.V.S.G. Murali Krishna, Air Pollution and Control, , Laxmi Publications, 1st Edition, 2017.

StevenC.Chapra, "Surface Water quality modeling", The McGraw-Hill-Companies Inc. 1st Edition, 2008.

e-Learning Source:

https://www.hindawi.com/journals/tswj/2013/231768/

http://envirocomp.org

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO2	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO3	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO4	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO5	3	0	0	0	0	0	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CE626	**Title of the Course**	Fundamentals of Sustainable Development	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To educate the students on the basic principles of sustainable development, its national and international aspects.						

Course Outcomes	
CO1	To inculcate the basic concept of Principles of Sustainable Development.
CO2	To impart the knowledge of Indians Judiciary System & Sustainable Development.
CO3	To enhance the fundamentals of Socio-economic Sustainable Development Systems.
CO4	To impart the knowledge of documentation and monitoring of developmental projects.
CO5	To edify the global aspects of sustainable development.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Principles of Sustainable Development	History and emergence of the concept of Sustainable Development, Definitions, Environmental issues and crisis, Resource degradation, greenhouse gases desertification social insecurity Industrialization Globalization and Environment.	08	CO1
2	Indian Judiciary System & Sustainable Development	Sustainable development in Indian scenario, Judicial System in India Induction of sustainability concepts through legal systems concepts principles doctrines case laws.	08	CO2
3	Sustainable Development and International Contribution	Components of sustainability, Complexity of growth and equity, International Summits, Conventions Agreements, Transboundary issues Action plan for implementing sustainable development – Moral obligations and Operational guidelines.	08	CO3
4	Socio-economic Sustainable Development Systems	Socio-economic policies for sustainable development- Strategies for implementing eco development programs – Sustainable development through trade – Economic growth Carrying Capacity – Public participation.	08	CO4
5	Global Aspects of Sustainable Development	Role of developed countries in the sustainable development of developing countries – Demographic dynamics and sustainability – Integrated approach for resource protection and management.	08	CO5

Reference Books:

Okechukwu Ukaga, Chris Maser, Michael Reichenbach, Sustainable Development, CRC Press, 1 edition, 2010.

Mackenthun, K.M., Basic Concepts in Environmental Management, 2nd edition, CRC Press, 2001.

Yehia Bahei-El-Din, Maguid Hassan, Advanced Technologies for Sustainable Systems, Springer; 1st ed., 2016.

Keekok Lee, Alan Holland, Desmond McNeil, Global Sustainable Development in the Twenty-First Century, Keele University Press (13 June 2000).

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc22_hs61/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO2	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO3	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO4	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO5	3	0	0	0	0	0	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CE627	**Title of the Course**	Cleaner Production	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To educate the students on complete management principles related to cleaner production and control of industrial pollution.						

Course Outcomes	
CO1	Student will be able to explain the concept of cleaner production.
CO2	Student will be able to learn about principles of pollution prevention.
CO3	Student will learn about concept of cleaner production.
CO4	Student will be able to understand the application of Life Cycle Assessment.
CO5	Student will be able to understand the related case studies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Sustainable Development – Indicators of Sustainability – Sustainability Strategies Barriers to Sustainability – Industrial activity and Environment – Industrialization and sustainable development – Industrial Ecology – Cleaner Production (CP) in Achieving Sustainability – Prevention versus Control of Industrial Pollution – Environmental Polices and Legislations – Regulations to Encourage Pollution Prevention and Cleaner Production – Regulatory versus Market- Based Approaches.	08	CO1
2	Pollution Prevention	Definition-Importance-Historical evolution-Benefits-Promotion-Barriers-Role of Industry, Government and Institutions -Environmental Management Hierarchy Source Reduction Techniques-Process and equipment optimization, reuse, recovery, recycle, raw material substitution-Internet Information and Other CP Resources.	08	CO2
3	Concept of Cleaner Production	Overview of CP Assessment Steps and skills, Preparing for the site visit, Information Gathering, and process flow diagram, material balance, CP Option Generation Technical and Environmental feasibility analysis-Economic valuation of alternatives, total cost analysis- CP Financing-Establishing a program-Organizing a program preparing a program plan-Measuring progress-pollution prevention and cleaner production Awareness plan -Waste audit-Environmental Statement.	08	CO3
4	Life Cycle Assessment	Elements of LCA-Life Cycle Costing -Eco Labelling-Design for the Environment International Environmental Standards-ISO 14001-Enironmental audit.	08	CO4
5	Case Studies	Dairy Industry, Distillery industry, Tannery Industry, Leather Industry, Paper and Pulp Industry.	08	CO5

Reference Books:

Paul L Bishop, "Pollution Prevention Fundamental and Practice", Waveland Pr Inc , 2nd Edition, 2004.

David Brennan , “Sustainable Process Engineering”, Pan Stanford; 1 edition 2012.

R. K. Sinha, “Cleaner Production: Greening Of Industries For Sustainable Development”, pointer publishers 1st edition, (2005)

Prasad modak, C.Visvanathan and Mandarparasnis "Cleaner Production Audit", Environmental System Reviews, No.38, Asian Institute of Technology, Bangkok, 2005.

e-Learning Source:

http://www.nptel.ac.in/courses/120108004/module9/lecture12

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO2	3	0	0	0	0	0	3	0	0	0	0	0	2	3
CO3	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO4	3	0	0	0	0	0	3	0	0	0	0	0	3	2
CO5	3	0	0	0	0	0	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CE628	**Title of the Course**	Environmental Geotechnology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To prepare the student who can work in a multi-disciplinary environment to anticipate and address evolving Environmental challenges of the 21st century.						

Course Outcomes	
CO1	Student will be able to explain Soil- Pollutant Interaction
CO2	Student will be able to learn about Characterization, Stabilization and Disposal
CO3	Student will learn about concept of Transport of Contaminants
CO4	Student will be able to understand the application of Detection and Testing Methods
CO5	Student will be able to understand the Remediation of Soil

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Soil- Pollutant Interaction	Introduction to geo environmental engineering – environmental cycle – sources, production and classification of waste – causes of soil pollution – factors governing soil-pollutant interaction- Physico-chemical behaviour and modelling - failures of foundations due to pollutants.	08	CO1
2	Characterization, Stabilization and Disposal	Safe disposal of waste – site selection for landfills – characterization of land fill sites – waste characterization –stability of landfills – current practice of waste disposal- passive contaminant system - Hazardous waste control and storage system – mechanism of stabilization -solidification of wastes – micro and macro encapsulation – absorption, adsorption, precipitation- detoxification — organic and inorganic stabilization.	08	CO2
3	Transport of Contaminants	Contaminant transport in sub surface – advection – diffusion – dispersion – governing equations – contaminant transformation – sorption – biodegradation – ion exchange – precipitation – hydrological consideration in land fill design – ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste – protecting aquifers.	08	CO3
4	Detection and Testing Methods	Methodology- review of current soil testing concepts – Proposed approach for characterization and identification of contaminated ground soil for engineering purposes Rational approach to evaluate and remediate contaminated sites – monitored natural reduction.	08	CO4
5	Remediation of Soil	Ex situ and in situ remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparing, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.	08	CO5

Reference Books:

Roberts, “Geotechnology: An Introductory Text for Students and Engineers”, Pergamon; 1st edition 2014.

Daniel, B.E., Geotechnical practice for waste disposal, Springer;1st edition 1993 edition (2012)

Robert W. Sarsby, “Environmental Geotechnics”, ICE Publishing; 2nd Revised edition, 2013

Hari D. Sharma, “Geo environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies”, John Wiley & Sons, 1st edition, 2004.

e-Learning Source:

http://www.nptel.ac.in/courses/105103025/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	0	0	2	3	0	0	0	0	0	2	3
CO2	3	2	2	0	0	2	3	0	0	0	0	0	2	3
CO3	3	2	2	0	0	2	3	0	0	0	0	0	3	2
CO4	3	2	2	0	0	2	3	0	0	0	0	0	3	2
CO5	3	2	2	0	0	2	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CE631	**Title of the Course**	Environmental Engineering Structures	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To develop basic knowledge about the concept of Environmental Engineering structure and apply the same in the field.						

Course Outcomes	
CO1	Student will be able to explain Design of Sewers
CO2	Student will be able to learn about Environmental Design of Concrete
CO3	Student will learn about Design of Water Retaining Structures
CO4	Student will be able to understand the basics of Underground Reservoirs and Swimming Pools
CO5	Student will be able to understand the Repair and Rehabilitation methods for Masonry, Concrete and Steel Structures.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Design of Sewers	General Introduction, Hydraulic formulas for determining flow velocities in sewers and drains, effect of flow variation on velocity in a sewer, Hydraulic characteristics of circular sewer section, structural design of sewers.	08	CO1
2	Environmental Design of Concrete	Pre stressed Concrete - anchorage for pipes - massive outfalls. Design of concrete roofing systems a) Cylindrical b) Spherical and c) Conical shapes using membrane theory.	08	CO2
3	Design of Water Retaining Structures	Design of circular, rectangular, spherical and Intze type of tanks- Design of pre stressed concrete cylindrical tanks.	08	CO3
4	Underground Reservoirs and Swimming Pools	Intake towers- Environmental design of settling tanks- clarifloculators- aeration tanks - effect of earth pressure and uplift considerations.	08	CO4
5	Repair and Rehabilitation	Identification of different types of Environmental and non-Environmental cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures.	08	CO5

Reference Books:

Krishna Raju, Pre stressed Concrete, Tata McGraw Hill, 5th edition, 2012.

N.C. Sinha., S.K .Roy., Reinforced Concrete, S. Chand and Co,1st Edition, 2007.

S. K. Garg, “Sewage Disposal and Air Pollution Engineering”, Khanna publication, 1st edition, 2008.

Poonam I. Modi, Chirag N. Patel, “Repair and Rehabilitation of Concrete Structures”, Prentice-Hall of India Pvt.Ltd, 1st edition, 2016.

e-Learning Source:

https://cpheeo.gov.in/upload/uploadfiles/files/engineering_chapter3.pdf

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	0	0	2	3	0	0	0	0	0	2	3
CO2	3	2	2	0	0	2	3	0	0	0	0	0	2	3
CO3	3	2	2	0	0	2	3	0	0	0	0	0	3	2
CO4	3	2	2	0	0	2	3	0	0	0	0	0	3	2
CO5	3	2	2	0	0	2	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CE632	**Title of the Course**	Surface And Ground Water Modelling	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To develop basic knowledge about the concept of Environmental Engineering structure and apply the same in the field.						

Course Outcomes	
CO1	Student will be able to explain Land Processes
CO2	Student will be able to learn about Environmental Design of Concrete
CO3	Student will learn about Ground Water Hydrology
CO4	Student will be able to understand the Experimental and Numerical Methods in Ground Water Hydrology
CO5	Student will be able to understand the Repair and Rehabilitation methods for Masonry, Concrete and Steel Structures.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Land Processes	Land Processes- Subsurface and Channel Processes- Precipitation – Rain gauge network, Abstractions, Infiltration, Evaporation, Transpiration, Process and models.	08	CO1
2	Theory of Hydrograph	Unit Hydrograph & S curve hydrograph, Dimensionless unit hydrograph, Watershed Model and Conceptual Models, River Hydrology & Distribution of water quality in Rivers, Estuaries, Physical and Hydrological Characteristics of Lakes.	08	CO2
3	Ground Water Hydrology	Occurrence and Movement of Ground water, Properties of aquifer, Groundwater flow equations, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.	08	CO3
4	Experimental and Numerical Methods in Ground Water Hydrology	Pumping tests, Analysis for unconfined and non leaky and leaky confined aquifer and water table aquifer, locating hydro geologic boundaries, Well design criteria. Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.	08	CO4
5	Flow Through Porous Media	Ground water and the hydrologic cycles - Ground water as a resource - Ground water and geologic processes. Physical properties and principles - Darcy's Law - Hydraulic Head and Fluid Potential - Piezometers and Nests. Hydraulic conductivity and permeability - Homogeneity and Anisotropy - Porosity and voids Ratio - Unsaturated flow and the water table - Steady state flow and Transient flow.	08	CO5

Reference Books:

Santosh Kumar Garg., "Irrigation Engineering & Hydraulic Structures" Khanna Publishers,1st edition, 2006.

Subramanya., "Flow in Open Channels", Tata Mc Graw Hill, 4th edition, 2009.

Vijay P. Singh ,"Handbook of Applied Hydrology" McGraw-Hill Education, 2 edition, 2016.

Reinhard Hinkelmann, "Efficient Numerical Methods and Information-Processing Techniques for Modeling Hydro- and Environmental Systems" springer; 5th edition. 2010.

e-Learning Source:

https://archive.nptel.ac.in/courses/105/103/105103213/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	0	0	2	3	0	0	0	0	0	2	3
CO2	3	2	2	0	0	2	3	0	0	0	0	0	2	3
CO3	3	2	2	0	0	2	3	0	0	0	0	0	3	2
CO4	3	2	2	0	0	2	3	0	0	0	0	0	3	2
CO5	3	2	2	0	0	2	3	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CE633	**Title of the Course**	Water Resources Systems Management	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• Student will be able to understand about the planning of reservoir. • Student will be able understand about the quality of water required by various crops and rain water harvesting method. • Student will learn about droughts and its managements. • Student will be able to learn the different software used in reservoir operation. • Student will be able to learn different optimization and modeling in water recourse system.						

Course Outcomes	
CO1	Student will be able to characterize different types of reservoir and dams.
CO2	Student will be able to explain about the quality of water used for various crops production and rain water harvesting methods.
CO3	Student will be able to explain the classification of drought.
CO4	Student will be able to use different software used in water recourse system.
CO5	Student will be able to explain different optimization method in water resource system.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Reservoir Planning	Reservoir planning and Management, Multi reservoir systems, Real time operation, River basin planning, water logging, soil salinity, salinity control.,Design of Dams, Non gravity dams, Weirs and Barrages, Conjunctive use of Irrigation water.	08	CO1
2	Quality of Water	Quality of Irrigation water, Contaminants and their effects on various crops. Rainwater Harvesting and Management – Different Types and Methods of Harvesting in urban and agricultural areas.	08	CO2
3	Droughts	Draught analysis, NCA classification, Direct and Indirect losses, Drought severity assessment, Drought Monitoring, Drought Management.	08	CO3
4	Floods	Introduction to systems approach, Linear programming, Problem formulation, Solution by simplex method, Application to design and operation of reservoir, Non Linear Programming, Sensitivity analysis, Monte Carlo simulation.	08	CO4
5	Optimization Methods in Water System Modelling	Ex situ and in situ remediation – solidification, bio – remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.	08	CO5

Reference Books:

Dilip Kumar Majumdar, "Irrigation Water Management (Principles & Practices)",Prentice Hall of India (P), Ltd, 2nd edition, 2013.

B L Gupta, "Water Resources Systems & Management", Standard Publications, 1st edition, 2008.

Pramod R. Bhave,"Water Resources Systems", Narosa publication, 1st edition, 2011.

Metcalf and Eddy, "Wastewater Engineering: Treatment, and Reuse Recovery", McGraw-Hill Education; 5 edition, 2013.

e-Learning Source:

http://www.nptel.ac.in/courses/105108081/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	0	0	2	0	0	2	0	0	0	0	0	2	3
CO2	1	0	0	2	1	0	2	0	0	0	0	1	2	3
CO3	1	0	0	2	0	0	2	0	0	0	0	0	3	2
CO4	1	1	1	2	1	0	2	0	0	0	0	1	3	2
CO5	1	0	0	2	0	0	2	0	0	0	0	0	2	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CE636	**Title of the Course**	Directed Study	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	0	0	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• To make learner aware about the latest technology and engineering practices in industries.						

Course Outcomes	
CO1	Awareness regarding the latest technology, engineering methodology and practices being used in industries.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	0	0	2	3	3	0	0	3	3	0	3	1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2019-20							
Course Code	CE699	**Title of the Course**	M Tech dissertation	**L**	**T**	**P**	**C**
Year	II	**Semester**	III and IV	0	0	0	20
Pre-Requisite	------	**Co-requisite**	------				
Course Objectives	• To develop individuality and problem analysis skill. • To nurture ability to perform literature review. • To improve critical thinking ability for formulation of plan. • To develop skill to use various engineering and technological tools. • To develop skill to think critically on research results. • To enhance the writing skill for research paper and dissertation.						

Course Outcomes	
CO1	Capability to work independently on a research-based problem.
CO2	Skill to perform review of available literature effectively to present research gap.
CO3	Aptitude to plan methodology for the attainment of various research objectives.
CO4	Competency to apply of various engineering and technological tools to carry research.
CO5	Ability to conclude work using critical thinking.
CO6	Proficiency in preparing presentation and report.

Unit No.	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Undergo industrial training in any respective industry in order to get familiar with the latest technology, engineering techniques and practices being used in the industry. Have to absorb some skill from the training identifying the area of improvement. The concepts/skills must be clearly understood and presented by the student. A hard copy of the report should be submitted to the Department after the completion of directed study.	03hrs	CO1, CO2, CO3, CO4, CO5 and CO6

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)													
PO-PSO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	0	0	0	3	3	0	0	3	3	3	0	3	0	3
CO2	0	0	0	3	3	0	0	3	3	3	0	3	0	3
CO3	0	0	0	0	3	0	0	0	3	3	0	3	0	3
CO4	0	0	0	3	3	0	0	0	3	0	0	3	0	3
CO5	0	0	0	3	3	0	0	3	3	3	0	3	0	3
CO6	0	0	0	0	3	0	0	3	3	3	0	3	0	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation