SYLLABUS

OF

M. TECH

(Hydraulics and Water Resources Engineering)

II YEAR

(CBCS)

DEPARTMENT OF CIVIL ENGINEERING

INTEGRAL UNIVERSITY LUCKNOW

STUDY AND EVALUATION SCHEME (Full Time)

M.Tech. (Hydraulics and Water Resources Engineering)

(w.e.f. Batch 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	CE675	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**					**500**

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

CE660 Remote Sensing and GIS in Water Resources Engineering
CE661 Hydro Power Engineering
CE662 Advanced Irrigation Engineering

Departmental Elective – III

CE664 Fluvial Hydraulics
CE665 Application of Soft Computing Technique in Hydrology
CE666 River Engineering

Departmental Elective – IV

CE668 Hydraulic Structures
CE669 Watershed Management
CE670 Earth and Rock Fill Dams

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE660	**Title of the Course**	Remote Sensing and GIS in Water Resources Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To know the basic principles and applications of Remote sensing and GIS in the context of water resources.						

Course Outcomes	
CO1	Students have ability to understand Remote Sensing, Principles of remote sensing, Energy interactions in the atmosphere and Energy interactions with earth surface features.
CO2	Students have ability to understand the Satellites and orbits, Spatial and spectral resolutions, Multispectral, Features of the remote sensing satellites.
CO3	Students have ability to understand the GIS, Data model and data structure, editing of data and method of interpolation.
CO4	Students will learn about the DEM, Sources of digital elevation data, Drainage pattern and catchment area delineation.
CO5	Students will learn about the application of remote sensing in watershed management and rainfall –runoff modelling.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Remote Sensing	Introduction, Types, Principles of remote sensing, EMR Spectrum, Energy sources and radiation principles, Energy interactions in the atmosphere, Energy interactions with earth surface features.	08	CO1
2	Remote Sensing Systems	Satellites and orbits, Spatial and spectral resolutions, Multispectral, Thermal and Hyper spectral remote sensing, Features of the remote sensing satellites.	08	CO2
3	Geographical Information System (GIS)	Introduction, Maps and map scales, Data model and data structures, Spatial data input & editing, Interpolation, Methods of interpolation.	08	CO3
4	Digital Image Processing And Elevation Modeling	Introduction, Types of DEM, Sources of digital elevation data, Radar interferometry, Shuttle radar topographic mission data, Drainage pattern and catchment area delineation.	08	CO4
5	Remote Sensing Applications	Applications in watershed management, Rainfall-runoff modelling, Irrigation management, Flood mapping, Drought assessment.	08	CO5

Reference Books:

Chow, V.T., 1988: Advances in Hydro Science McGraw Hill.

Drury, S.A., 1987: Image Interpretation in Geology. Allen and Unwin

Gupta, R.P.., 1990: Remote Sensing Geology. Springer Verlag

Miller, V.C., 1961: Photogeology. McGraw Hill

Company Todd, D.K., 1980: Groundwater Hydrology. John Wiley

e-Learning Source:

https://nptel.ac.in/courses/105102015/

https://nptel.ac.in/courses/105108077/

	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	2	1	0	1	1	0	2	0	1	1	0	0	2	3
CO2	2	1	0	1	1	0	1	0	1	0	1	2	2	3
CO3	3	1	2	2	2	0	1	0	1	0	1	1	2	3
CO4	3	1	2	1	1	0	0	0	1	0	1	2	2	3
CO5	3	1	3	1	1	1	1	0	1	0	0	2	2	3

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE661	**Title of the Course**	Hydro Power Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand the hydropower, types of hydropower plant, Penstock, Turbine, design of intake, water hammer theories and design of surge tank.						

Course Outcomes	
CO1	Students will learn about the hydropower energy, hydropower development in India, Hydropower plants, Surface and underground power stations, Low medium-high head plants-layout and pumped storage plants
CO2	Students will learn about the penstocks, Design of Penstocks, design criteria of power canals, Location, function and types of intakes and design of intakes
CO3	Students will learn about the Rigid and elastic water column theories, water hammer pressure. Behavior of surge tanks, types of surge tanks and hydraulic design of tank
CO4	Students will learn about the Hydraulic turbines and types and classification, constructional features, hydraulic analysis, characteristic curves, governing of turbine, hydraulic principles and design
CO5	Students will learn about the Power house structures, Power house substructure and Power house superstructure, Layout dimensions and deign considerations

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Sources and forms of energy, hydropower development in India, Hydropower plants, classification: Surface and underground power stations, Low medium-high head plants-layout and components, pumped storage plants, tidal power plants, Load and power studies	08	CO1
2	Penstocks and Power Canal	Classification of penstocks, Design of Penstocks, economic diameter, bends, anchor blocks, surges in canals design criteria of power canals. Intake structures: Location function and types of intakes, energy losses at intake trash rock, design of intakes	08	CO2
3	Water Hammer and Surge Tank	Rigid and elastic water column theories, water hammer pressure. Behavior of surge tanks, types of surge tanks, hydraulic design, design of simple surge tank-stability	08	CO3
4	Turbines	Hydraulic turbines and types and classification, constructional features, hydraulic analysis, selection, characteristic curves, governing of turbine, drafts tubes-types, hydraulic principles and design. Gates and valves- types. Design of air vent.	08	CO4
5	Power House Planning	Powerhouse structures, Powerhouse substructure and Powerhouse superstructure Layout and dimensions, deign considerations.	08	CO5

Reference Books:

Hydro power structures by Varhney R.S.

Hydroelectric engineering practice by Brown J.G.

Water power development (Vols. I, II and III) by E. Mosonyi.

A Hand Book on hydrology by VenTe Chow.

Hydroelectric practice by Creager and Justin.

e-Learning Source:

http://www.usbr.gov/power/edu/pamphlet.pdf

https://nptel.ac.in/courses/112107291

	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	2	2	2	1	0	1	2	0	2	1	0	1	2	3
CO2	2	1	3	2	0	1	0	0	2	1	1	2	2	3
CO3	2	1	3	2	0	1	0	0	1	0	1	0	2	3
CO4	2	2	3	1	0	1	1	0	2	1	1	2	2	3
CO5	2	0	3	2	0	1	0	0	0	1	1	2	2	3

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE662	**Title of the Course**	Advanced Irrigation Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• To introduce the water resources in India, need of irrigation, advantages and Criteria for good Irrigation management. • To learn about the classification of soil water, soil water plant relationship and soil moisture measurement. • To introduce the basic Water requirement of crops, Evapotranspiration and consumptive use of water. • To introduce the Surface irrigation methods, types and canal design. • To learn the sprinkler and drip irrigation and components design.						

Course Outcomes	
CO1	To understand the water resources in India and their needs and criteria for good irrigation management.
CO2	To understand the basic concept of soil water and plant relationship and soil moisture measurement.
CO3	To understand the basic concept of requirement of water for a crops and consumptive use of water.
CO4	To understand the methods of surface irrigation, types and canal design.
CO5	To understand the sprinkler and drip irrigation and criteria of adopting the method of irrigation and design of the components.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Development of Irrigation	Water Resources of India, Irrigation Need, Advantages and Disadvantages, National Water Policy and Inadequacy of Irrigation Management, Criteria for good Irrigation management.	08	CO1
2	Soil Water Plant Relationship	Soil physical properties influencing Soil-water relationship-Forms and occurrence of Soil Water- Classification of Soil Water- Soil Water Constants- Energy concept of Soil Water-Forces acting on Soil Water- Soil Water Potential concept- Soil Water retention- Soil Moisture Measurement.	08	CO2
3	Crop Water Requirement	Water requirement of crops- Evapotranspiration and Consumptive use- Methods of estimating Evapotranspiration- Effective Rainfall- Irrigation Requirement-Duty of Water- Irrigation Efficiencies- Irrigation Scheduling- Irrigation measurement.	08	CO3
4	Surface Irrigation Methods	Canal network and canal design- Surface irrigation methods- Types- Border irrigation, Furrow irrigation and Strip irrigation- Specifications, Hydraulics and Design.	08	CO4
5	Drip and Sprinkler Irrigation Method	Sprinkler and Drip- History and development, Types, Components, Design and Layout, Performance Evaluation, Operation and Maintenance.	08	CO5

Reference Books:

Majumdar D.P," Irrigation Water Management Principles and Practices", Prentice Hall of India, New Delhi, 2004.

Michael A. M., "Irrigation Theory and Practice", Vikas Publishing House, New Delhi, 2009.

Sharma R.K and Sharma T.K., "Irrigation Engineering", S. Chand, New Delhi, 2008.

e-Learning Source:

https://nptel.ac.in/courses/105102159/

https://nptel.ac.in/courses/105105110/

	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	1	0	0	0	1	2	0	0	0	2	0	0	0
CO2	3	1	1	0	0	1	2	0	0	0	0	0	0	0
CO3	2	2	1	0	0	2	2	0	0	0	0	0	0	0
CO4	2	0	3	0	0	2	1	1	1	2	1	1	0	0
CO5	2	1	3	0	0	2	2	1	1	2	1	1	0	0

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE664	**Title of the Course**	Fluvial Hydraulics	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand the behavior of sediment transport in alluvial channels, design the stable alluvial channel and solve various civil engineering problems encountered in fluvial hydraulics.						

Course Outcomes	
CO1	Students will understand about the Reservoir sedimentation, site selection, critical tractive force of cohesion less and cohesive materials, regimes of flow, importance and prediction of regimes of flow.
CO2	Students will understand about the Resistance to flow and velocity distribution in alluvial streams, Bed load equations, suspended load, and general considerations about sediment distribution equation.
CO3	Students will have ability to understand about the Total load transport, microscopic and macroscopic methods based on a single size and fraction wise size calculations.
CO4	Students have ability to Design of stable channels in alluvium: variables in channel design, general comments on regime and tractive force methods of channel design.
CO5	Students will understand the Bed level variation in alluvial streams, local scour, degradation, aggradations, silting of reservoir, estimation of silt, distribution of sediment in reservoir, life of reservoir, and sediment flow through pipes.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Sediment Properties and Reservoir	Sediment properties, Reservoir sedimentation, types of reservoirs, site selection, incipient motion of sediment, competent velocity, lift concept, critical tractive force of cohesion less and cohesive materials, regimes of flow, ripple and dune regimes, anti-dune regime, importance and prediction of regimes of flow.	08	CO1
2	Sediment Distribution Properties	Resistance to flow and velocity distribution in alluvial streams, Bed load equations based on dimensional considerations and semi theoretical equations, suspended load, general considerations about sediment distribution equation.	08	CO2
3	Sediment Sampling System	Total load transport, microscopic and macroscopic methods based on a single size and fraction wise size calculations, Sediment samplers and sampling, bed load and suspended load sampling.	08	CO3
4	Design criteria of Stable Channels -I	Design of stable channels in alluvium: variables in channel design, general comments on regime and tractive force methods of channel design.	08	CO4
5	Design Criteria of Stable Channels -II	Bed level variation in alluvial streams, local scour, degradation, aggradation, silting of reservoir, estimation of silt, distribution of sediment in reservoir, life of reservoir, sediment flow through pipes.	08	CO5

Reference Books:

R.J. Garde and K G RangaRaju, Mechanics of sediment transport through alluvial Channels, New Age International (P) Limited, Publishers, New Delhi.

W R White, A D Crabbe, H Milli, Sediment Transport: New Approach and Analysis," Journal of the Hydraulics Division, HY11, American Society of Civil Engineers. ... "Shore Protection Manual," Washington, 1975.

A J Raudkivi, Loose Boundary Hydraulics, CRC Press, Taylor & Francis, USA.

e-Learning Source:

https://nptel.ac.in/content/storage2/courses/105105110/pdf/m3l07.pdf

https://nptel.ac.in/content/storage2/courses/105105110/pdf/m3l07.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	2	2	0	2	0	1	0	0	1	2	0	1	2	3
CO2	2	1	0	0	2	1	0	0	2	1	0	1	2	3
CO3	2	1	2	1	1	0	1	0	2	1	0	0	2	3
CO4	2	2	3	2	0	0	1	0	1	2	1	0	2	3
CO5	2	2	3	2	0	0	1	0	2	1	0	1	2	3

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE665	**Title of the Course**	Application of Soft Computing Technique in Hydrology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To learn the basic concepts of Soft Computing, To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems. To apply soft computing techniques to solve problems.						

Course Outcomes	
CO1	Students will be able to understand the Fuzzy computing, neural computing, genetic algorithms, application in water resources engineering and Model of artificial neuron.
CO2	Students will be able to understand the back propagation learning, back propagation algorithm, associate memory: description and Auto-associate memory.
CO3	Students will be able to understand Recap –supervise, unsupervised, back prop algorithm, competitive learning and unsupervised ART Clustering.
CO4	Students will be able to understand the fuzzy set membership, operations, properties Fuzzy relations, fuzzy logic, fuzzy inference and fuzzy rule based system.
CO5	Students will be able to understand the operators of genetic algorithm, basic genetic algorithm. integration of neural networks, Fuzzy back propagation networks and Fuzzy associative memories.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Soft Computing	Introduction: Fuzzy computing, neural computing, genetic algorithms, associate memory, adoptive resonance theory, application in water resources engineering. Fundamentals of neural network: Introduction, model of artificial neuron. Architectures, learning methods, Taxonomy of NN Systems. Single layer NN systems, applications.	08	CO1
2	Back Propagation Network	Background, back propagation learning, back propagation algorithm, associate memory: description, Auto-associate memory, bidirectional Hertoassociative.	08	CO2
3	Adaptive Resonance Theory	Recap – supervise, unsupervised, backprop algorithm; competitive learning; stability – plasticity Dilemma (SPD) ART networks Iterative Clustering, unsupervised ART Clustering.	08	CO3
4	Fuzzy Set Theory	Introduction fuzzy set membership, operations, properties Fuzzy relations, Fuzzy system: introduction fuzzy logic Fuzzification, fuzzy inference fuzzy rulebased system, Defuzzification.	08	CO4
5	Fundamentals of Genetic Algorithms	Introduction, Encoding, operators of genetic algorithm, basic genetic algorithm. Hybrid system: integration of neural networks, Fuzzy logic and genetic algorithms, GA based back propagation networks, Fuzzy back propagation networks, Fuzzy associative memories.	08	CO5

Reference Books:

Neural networks, Fuzzy logic and genetic algorithms: synthesis and applications, S. Rajasekaran, G A vijaylakshami, PHI

Chin Teng Lin, C S George Lee Neuro Fuzzy systems PHI.

Kishanmehrotra , Elements of artificial neural network ,MIT Press

e-Learning Source:

https://nptel.ac.in/courses/106/105/106105173/

	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	2	2	3	2	3	0	0	0	1	0	2	1	2	3
CO2	1	2	0	2	2	0	1	0	1	1	2	0	2	3
CO3	2	2	1	0	2	0	0	0	1	1	1	0	2	3
CO4	2	2	0	0	2	0	0	0	1	0	1	1	2	3
CO5	2	2	1	0	3	0	1	0	1	0	0	1	2	3

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE666	**Title of the Course**	River Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand theoretical concepts of water and sediment movements in rivers and also to inculcate the benefits of fluvial system to the society.						

Course Outcomes	
CO1	To understand the Primary function of River, Water and Sediment loads of river, Rivers in India.
CO2	To understand the Physical Properties of river and Equations of different types of flow in rivers, velocity profile, uniform and non-uniform, turbulence, Diffusion and Dispersion.
CO3	To understand about the Stability of Channel, hydraulic geometry of downstream, meandering, River dynamics, degradation and aggradations of river bed.
CO4	To understand about Mapping, Stage, Discharge Measurements in river, Sediments, Bed and suspended load, Rigid and mobile bed, Water Quality and ecological model.
CO5	To understand the river training work and river regulation work, flood plain measurement and river stabilization.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	River Functions	Primary function of a river – River uses and measures – Water and Sediment loads of river – Rivers in India, Himalaya and Peninsular.	08	CO1
2	River Hydraulics	Physical Properties and Equations – Steady flow in rivers – uniform and non-uniform – Turbulence and velocity profiles –resistance coefficient, Boundary conditions and back waters, Transitions, Rating Curve, Unsteady flow in rivers: Propagative of surface waves – Characteristics, flood waves – kinematic and diffusion analogy – velocity of propagation of flood waves–Flood wave –Maximum Fundamental relationships for flow and transport, Diffusion and Dispersion.	08	CO2
3	River Mechanics	River Equilibrium: Stability of Channel – regime relations – river bend equilibrium – hydraulic geometry of downstream – Bars and meandering - River dynamics – degradation and aggradation of riverbed – Confluences and branches – River Data base.	08	CO3
4	River Surveys and Model	Mapping, Stage and Discharge Measurements, Sediments, Bed and suspended load, Physical hydraulic Similitude, Rigid and mobile bed, Mathematical – Finite one dimensional, multi – dimensional – Water Quality and ecological model.	08	CO4
5	River Management	River training works and river regulation works – Flood plain management – waves and tides in Estuaries – Interlinking of rivers – River Stabilization.	08	CO5

Reference Books:

Janson PL. Ph., Lvan Bendegam Jvanden Berg, Mdevries A. Zanen (Editors), Principles of River Engineering – The non-tidal alluvial rivers – Pitman, 1979.

Pierre Y. Julien., River Mechanics, Cambridge University Press, 2002

K.L Rao INDIA's WATER WEALTH – Orient Longman Ltd., 1979

Ranga Raju – New Age Int. Publications.

e-Learning Source:

https://nptel.ac.in/content/storage2/courses/105105110/pdf/m6l01.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	1	0	0	0	2	2	0	0	1	1	0	1	1
CO2	2	2	1	2	0	2	2	0	0	0	1	1	2	2
CO3	3	2	3	1	0	1	1	0	0	0	1	1	2	2
CO4	3	2	1	1	0	1	3	0	0	0	1	0	2	2
CO5	2	3	2	1	0	1	1	0	0	2	1	1	2	2

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE668	**Title of the Course**	Hydraulic Structure	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	• To understand the basic concept of site selection of dam and Types of dams. • To understand the Design criteria, Elementary profile of gravity dam and stability of dam. • To know the safety criteria, force acting on the gravity dam, function of spillway and energy dissipaters.						

Course Outcomes	
CO1	Students will be able to understand the criteria of site Selection of dam, Forces acting on darns, Elementary profile of a gravity dam, Stability analysis and methods of determination of shear stress.
CO2	Students will be able to understand the Arch dam, Types of arch dams, Design of arch dam, Valleys suited for arch darns, Thin cylinder theory, Most economical central angle and Effects of foundation elasticity on arch dam.
CO3	Students will be able to understand the Buttress dam, Types of buttress darn, Design principles, Buttress design by Unit column theory and Basic shape of buttress.
CO4	Students will be able to understand the Spillways, Types of spillways, Design principles of spillway, Hydraulic design of spillways and Energy dissipation below spillways.
CO5	Students will be able to understand Theory of similarity, dimensional analysis, Basic concepts, Froude law, Reynolds law, Mach law, Cavitations number and Modeling technique.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Gravity Dams	Introduction, Selection of dam sites, Forces acting on darns, Elementary profile of a gravity dam, Stability analysis and Safety criteria, Graphical determination of shear stress, Galleries. Difference between weirs & barrages.	08	CO1
2	Arch Dam	Definition, Types of arch dams, Design of arch dam, Valleys suited for arch darns, Thin cylinder theory, Most economical central angle, Effects of foundation elasticity on arch dam.	08	CO2
3	Buttress Dam	Types of buttress darn, Selection of buttress dam, Most economical profile having no tension, Design principles, Buttress design by Unit column theory, Basic shape of buttress.	08	CO3
4	Spillways and Energy Dissipaters	Spillways, Types of spillways, Design principles of spillway, Hydraulic design of spillways, Energy dissipation below spillways, Bucket type energy dissipaters, Design of various types of stilling basins.	08	CO4
5	Hydraulic Models	Theory of similarity, dimensional analysis, Basic concepts, Froude law, Reynolds law, Mach law, Cavitation number, Modeling technique.	08	CO5

Reference Books:

Engineering for Dams by Creager, Justin & Hinds, Willey Eastern Pvt. Ltd., Delhi.

Concrete Dams by R.S. Varshney, Oxford & IBH Pub. Co. Delhi.

Dams-Part I Gravity Dams by K.B. Khushalani, Oxford & MN, Delhi.

Design of Weirs on Permeable Foundations, CBIP Pub. No 20, Delhi.

Garg, S.K., "Irrigation Engineering and Hydraulic Structures," Khanna Publishers.

e-Learning Source:

https://nptel.ac.in/content/storage2/courses/105105110/pdf/m4l06.pdf

https://nptel.ac.in/content/storage2/courses/105105110/pdf/m4l04.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	2	1	1	1	0	0	1	0	2	2	0	1	0	0
CO2	2	1	3	1	0	0	2	0	1	0	2	1	0	0
CO3	2	1	3	0	0	0	2	0	1	1	2	0	0	0
CO4	2	0	3	0	0	0	2	0	2	0	1	2	0	0
CO5	2	1	3	2	0	0	2	0	0	0	1	2	0	0

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE669	**Title of the Course**	Watershed Management	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand the basic principle of watershed management, environmental guidelines for water quality, factors of soil erosion, soil conservation practices and social aspects of watershed management.						

Course Outcomes	
CO1	Students will be able to understand the Watershed, characteristics, watershed management, Typical watershed problems, Principles of watershed management, Watershed management policies and National water policy
CO2	Students will be able to understand the Water quality, pollution, Types and sources of pollution, water quality modeling and Environmental guidelines for water quality
CO3	Students will be able to understand Sustainable watershed management, Principles, Natural resources management, Sustainable land management practices, Soil erosion: causes, processes, erosion factors, Water erosion, Types, Estimation of soil loss Wind erosion and Soil conservation practices.
CO4	Students will be able to understand the Social aspects of watershed management: Community participation, Private sector participation, Socio-economy Integrated development, Water legislation and implementations
CO5	Students will be able to understand Standard modeling approaches, system concept for watershed modeling, modeling of rainfall, runoff process, subsurface flows and groundwater flow.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction	Watershed, characteristics, Watershed deterioration, Typical watershed problems, Principles of watershed management, Introduction to watershed management, Different stakeholders and their relative importance, watershed management policies and National water policy.	08	CO1
2	Management of Water Quality	Water quality and pollution, Types and sources of pollution, water quality modeling, water quality modeling, Environmental guidelines for water quality.	08	CO2
3	Sustainable Watershed Management	Sustainable watershed management, Principles, Natural resources management, Sustainable land management practices, Soil erosion: causes, processes, erosion factors, Water erosion, Types, Estimation of soil loss wind erosion estimation of soil loss, Wind erosion, Soil conservation practices.	08	CO3
4	Socio-economic Aspects of Watershed Management	Social aspects of watershed management: Community participation, Private sector participation, Institutional issues, Socioeconomic Integrated development, water legislation and economy, Integrated development, Water legislation and implementations, Case studies.	08	CO4
5	Watershed Modeling	Standard modeling approaches and classifications, system concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall, runoff process, subsurface flows and groundwater flows.	08	CO5

Reference Books:

Chow. V.T. Handbook of Applied Hydrology. Mc Graw-Hill, New York

Rattan Lal. Soil Erossion in the Tropics. McGraw-Hill New York

J.V.S. Murthy, "Watershed Management,"New age International publishers New Delhi

Das Madan Mohan, "Watershed Management," PHI Learning publishers

e-Learning Source:

https://nptel.ac.in/courses/105101010/

	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	2	1	1	1	0	0	1	0	2	2	0	1	0	0
CO2	2	1	3	1	0	0	2	0	1	0	2	1	0	0
CO3	2	1	3	0	0	0	2	0	1	1	2	0	0	0
CO4	2	0	3	0	0	0	2	0	2	0	1	2	0	0
CO5	2	1	3	2	0	0	2	0	0	0	1	2	0	0

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CE670	**Title of the Course**	Earth and Rock Fill Dams	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	To understand the method of construction of earthen and rock fill dam, method of controlling of seepage in earthen dam and protection of the slops.						

Course Outcomes	
CO1	To understand the basic concept of earthen dam their types cause of failure, Methods of construction, Pore-Water Pressure and its Significance in the Design of Earth Dams.
CO2	To understand about the Seepage Discharge through the Soil, Phreatic line and Determination of Phreatic Line for Homogeneous section with a Horizontal Filter and without Filter.
CO3	To understand how to control seepage through the embankment and foundation of the earthen dam and how to design the filter and protection of slop.
CO4	To understand about the location of slip circle and stability of slope during the sudden drawdown and steady seepage.
CO5	To understand about the rockfill dams, placement of material and compaction and design of rockfill dams.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Earthen Dam	Introduction: Earthen dam, Types of earthen dam, Methods of construction, Cause of failure of earthen dam, Shearing Strength of Soils, Various Kinds of Densities and Their Relations, Pore-Water Pressure and its Significance in the Design of Earth Dams	08	CO1
2	Seepage Analysis	Seepage Discharge through the Isotropic Soil and Non- isotropic soil, Phreatic line, Determination of Phreatic Line for Homogeneous section with a Horizontal Filter and without Filter, Phreatic Line for a Zoned Section	08	CO2
3	Seepage Control in Earth Dams	Seepage Control Through Embankments, Seepage Control Through Foundations, Design of Filters, Protection of Upstream Slope, Protection of Downstream Slope	08	CO3
4	Stability of Slopes	General concepts, Stress relationship and shear parameters, Swedish Slip Circle Method or The Slices Method. Location of Centre of Slip Circle, Stability of Downstream Slope during Steady Seepage, Stability of Upstream Slope During Sudden Drawdown, Stability of the foundation against Shear	08	CO4
5	Rock Fill Dam	Definition and Types of Rockfill Dams, Foundation Design for Rockfill Dams, Embankment Design for Rockfill Dams, Stability, Placement of Rockfill Materials, Compaction, Membrane Design for Rockfill Dams.	08	CO5

Reference Books:

Sharma H. D., "Embankment Dams," Oxford and IBH Pub., 1991

B. Singh and R. S. Varshney, "Engineering for Embankment Dams," A. A. Balkema Publishers

Robin Fell and Patrick MacGregor., "Geotechnical Engineering of Dams," David Stapledon, Graeme Bell., CRC Press

IS 7894 (1975): Code of practice for stability analysis of Earth dams

e-Learning Source:

https://nptel.ac.in/content/storage2/courses/105105110/pdf/m4l04.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	3	3	1	0	2	3	0	0	0	2	2	2	3
CO2	3	3	1	2	0	2	0	0	1	0	1	1	2	3
CO3	2	3	1	1	0	2	0	0	0	0	1	1	2	3
CO4	2	1	1	3	0	2	0	0	0	0	1	1	2	3
CO5	3	1	3	1	0	2	1	0	1	0	2	2	2	3

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CE675	**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.

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 and CO2

	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	3	0	0	3	3	0	3	3	3

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

Integral University, Lucknow

Effective from Session: 2016-17							
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	NIL	**Co-requisite**	NIL				
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