Curriculum and Syllabi

M. Tech. Degree Programme

Water Resources Engineering

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY
CALICUT
# DEPARTMENT OF CIVIL ENGINEERING

# Curriculum for M. Tech. in
Water Resources Engineering

## First Semester

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TOTAL CREDITS = 11 (Core) + 9 (Electives) = 20

## Second Semester

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TOTAL CREDITS = 11 (Core) + 9 (Electives) = 20

National Institute of technology Calicut 2 Water Resources Engineering, Dept. of Civil Engg.
### Third Semester

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TOTAL CREDITS = 8 (Core) + 0 or 3 (Elective) = 8 (11)

### Fourth Semester

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TOTAL CREDITS = 12

### Total Credits

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<td>Semester - III</td>
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<td>Semester - IV</td>
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# LIST OF ELECTIVES

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<td>CE6524</td>
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<td>CE6525</td>
<td>Hydrogeology and Groundwater Development</td>
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<td>CE6531</td>
<td>Environmental Impact Assessment of Water Resources Projects</td>
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<td>7</td>
<td>CE6532</td>
<td>Water Quality Modelling and Management</td>
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<td>8</td>
<td>CE6533</td>
<td>Hydropower</td>
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<td>9</td>
<td>CE6534</td>
<td>Watershed Management</td>
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<td>CE6535</td>
<td>Environmental Hydraulics</td>
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<td>Urban Hydrology and Drainage</td>
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<td>CE6543</td>
<td>Coastal Engineering and Coastal Zone Management</td>
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<td>CE6544</td>
<td>Pollution Science and Engineering</td>
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<td>CE6545</td>
<td>Geographical Information Systems and its Applications in Hydrology</td>
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BRIEF SYLLABI

CE6501 Advanced Mechanics of Fluids

Prerequisite: Nil


Total Hours: 42

CE6502 Surface Water Hydrology and Hydrologic Systems

Pre-requisite: Nil


Total Hours: 42 Hrs.

CE6503 Flow And Transport in Porous Media

Prerequisite: Nil


Total Hours: 42
CE6591  Computational Laboratory

Prerequisite: Nil

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Flow and transport problems in pipelines, Flow and transport problems in open channels including rivers, Modelling lakes and reservoir, Groundwater flow and transport, Flow and transport in the vadose zone, Coastal circulation and sediment transport, Storm and sanitary sewer design, Flow routing in channels and reservoirs.

Total Hours: 42

CE6511  Water Resources Systems Analysis and Design

Prerequisite: Nil

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Total Hours: 42

CE 6512  Remote Sensing and Its Applications in Water Resources Engineering

Prerequisite: NIL

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Total Hours: 42 Hrs.
CE6513 Computational Hydraulics and Hydrology

Prerequisite: Nil


Total Hours: 42

CE6521 Statistical Methods in Hydrology

Prerequisite: Nil


Total Hours: 42

CE6522 Hydraulic Modelling

Prerequisite: Nil

Review of theoretical background required for hydraulic modeling. Development of physical models – dimensional analysis and principles of similitude, non-dimensional numbers employed in hydraulic modelling, tools and procedures, Modelling of open channel systems, closed conduit systems and urban drainage systems. Environmental modelling of open channel systems, Modelling of estuaries, coastal processes, nearshore structures, and hydraulics structures.

Total Hours: 42
CE6523 Finite Element Method in Hydro Engineering

Prerequisite: Nil


Total hours: 42

CE6524 Applied Hydraulic Modelling

Prerequisite: Nil

Conservation laws - mass, momentum and energy. Governing equations of fluid flow, initial and boundary conditions. Pipe flow - review of basic hydraulic principles design principles, analysis of distribution networks, Pump-pipeline and turbine-pipeline systems. Transients in pipelines, Open channel flow, critical flow and uniform flow concepts, flow in erodible channels, channel design, CBI & P method, tractive force method, Gradually varied flow compound channels, canal delivery problem, Rapidly varied flow design of spillways, Dam break analysis, Main canal and flow distribution control, decentralised control, canal automation, hardware and software components in automation systems.

Total Hours: 42

CE6525 Hydrogeology and Groundwater Development

Prerequisite: Nil

Groundwater and the hydrologic cycle, problems and perspectives, groundwater balance, status of groundwater development, major hydrogeologic formations in India. Basic concepts of groundwater management, Surface and subsurface investigations of groundwater, Types of wells, design and construction of open wells, Types of tube wells, multiple well system, radial wells and infiltration galleries, design of tube wells, Construction of bored and driven tube wells, Well development and well completion, Pumps used for lifting water, different types of selection of pumps, power requirement, efficiency and economics.

Total Hours: 42
CE6531 Environmental Impact Assessment of Water Resources Projects

Prerequisite: Nil

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Total Hours: 42

CE6532 Water Quality Modelling and Management

Prerequisite: Nil

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Total Hours: 42

CE6533 Hydropower

Prerequisite: Nil

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Total Hours: 42
CE6534 Watershed Management

Pre-requisite: Nil


Total Hours: 42Hrs.

CE6535 Environmental Hydraulics

Prerequisite: Nil

 Fundamental relationships for flow and transport, Reynold’s time-averaged mean flow and transport equations, model resolution, solution techniques, data requirements. Estimation of design flows. Models for rivers and streams - Completely mixed and Incompletely mixed systems. BOD and oxygen saturation, Streeter-Phelps equation, point and distributed sources. Rivers and streams- stream hydro-geometry, low- flow analysis, dispersion and mixings, hydraulic methods for steady and unsteady flows and solution techniques, routing and water quality problems. Mixing in lakes and reservoirs, Transport and mixing in estuaries. Hydraulic analysis of various units in water treatment and wastewater treatment plants. Turbulent jets and plumes, ocean wastewater discharge systems.

Total Hours: 42

CE6541 IT Applications in Water Resources Engineering and Management

Prerequisite: Nil

Trends in information technology, artificial intelligence and knowledge, based expert systems, parallel processing, applications. Artificial neural network, genetic algorithms, fuzzy logic, applications. Satellite remote sensing, geographical information system, global positioning system, applications. Use of multimedia, web based engineering analysis and modelling, virtual reality, applications.

Total Hours: 42
CE6542 Urban Hydrology and Drainage

Prerequisite: Nil


Total Hours: 42 Hrs.

CE6543 Coastal Engineering and Coastal Zone Management

Prerequisite: Nil


Prerequisite: Nil

CE6544 Pollution Science

Prerequisite: Nil

Module 1: (10 hours)
Total Hours: 42

CE6545  Geographical Information Systems and Its Applications in Hydrology

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Prerequisite: Nil


Total Hours: 42 Hrs.
CE6501  Advanced Mechanics of Fluids

Prerequisite: Nil
Total Hours: 42

Module 1: (11 hours)

Module 2: (11 hours)

Module 3: (10 hours)

Module 4: (10 hours)

References
CE6502 Surface Water Hydrology and Hydrologic Systems

Pre-requisite: Nil
Total Hours : 42Hrs.

Module 1: (12 hours)

Module 2: (10 hours)

Module 3: (10 hours)

Module 4: (10 hours)

References
Module 1:(10 hours)

Module 2:(12 hours)
Groundwater and well hydraulics: steady and unsteady radial flows in aquifers (confined, unconfined and leaky), effect of well bore storage, multiple well systems, partially penetrating wells, bounded aquifers, characteristic well losses, specific capacity. Slug tests. Groundwater modelling, Inversemodelling in groundwater.

Module 3:(10 hours)

Module 4:(10 hours)
Introduction to groundwater contamination.Quality of groundwater: measures of quality, groundwater samples, physical, chemical and biological analyses, water quality criteria, and salinity. Transport and transformation of contaminants in groundwater: processes, formulation of the governing equations and initial and boundary conditions, solutions for simple cases.

References

CE6591  Computational Laboratory

Prerequisite: Nil
Total Hours: 42

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To familiarise and give hands on training to students in formulating numerical models and using standard software for analyzing the following problems:

- Flow and transport problems in pipelines
- Flow and transport problems in open channels including rivers
- Modelling lakes and reservoirs
- Groundwater flow and transport
- Flow and transport in the vadose zone
- Coastal circulation and sediment transport
- Storm and sanitary sewer design
- Flow routing in channels and reservoirs.
CE6511 Water Resources Systems Analysis and Design

Prerequisite: Nil  
Total Hours: 42

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Module 1: (11 hours)

Module 2: (11 hours)

Module 3: (10 hours)
Modelling of Reservoir Systems: (1) Deterministic Inflow – reservoir sizing, sequent peak analysis, reservoir capacity estimation using LP, storage yield function. Reservoir operation – standard operating policy, optimal operating policy using LP, standard policy using DP, simulation of reservoir operation for hydropower generation. (2) Random inflow – chance constrained LP, linear decision rule, deterministic equivalent of a chance constraint, reliability-based reservoir sizing, stochastic DP for reservoir operation – state variable discretization, inflow as a stochastic process, steady state operating policy, real-time operation.

Module 4: (10 hours)
Linear Programming Applications – irrigation water allocation for single and multiple crops, multireservoir system for irrigation planning, reliability capacity tradeoff for multicrop irrigation, reservoir operation for irrigation, reservoir operation for hydropower optimization. Dynamic Programming Applications – optimal crop water allocation, steady state reservoir operating policy for irrigation, real-time reservoir operation for irrigation.

REFERENCES

National Institute of technology Calicut 17  Water Resources Engineering, Dept. of Civil Engg.
CE 6512  Remote Sensing and Its Applications in Water Resources Engineering

Prerequisite: NIL
Total Hours: 42 Hrs.

Module I (11 hours)

Module II (11 hours)

Module III (11 hours)
Image classification – Supervised, Unsupervised and Hybrid classification – Supervised classification algorithms – Unsupervised classification algorithms - Accuracy assessment - Principal component transformation

Module IV (9 hours)

References
CE6513 Computational Hydraulics and Hydrology

Prerequisite: Nil
Total Hours: 42

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**Module 1:** (10 hours)

**Module 2:** (11 hours)
Finite difference methods applied to steady state and transient flow problems – formulation and solution, examples. Similarity solutions in subsurface hydrology.

**Module 3:** (11 hours)Basics of FEM, different formulations, variational, weighted residual and Galerkin methods, appropriateness of these formulations to different problems, domain discretisation - different types of elements, integral equations for element matrices, derivations of boundary conditions, sources and sinks, finite difference in time domain, matrix equations, solution techniques, examples.

**Module 4:** (10 hours)

**References**
Prerequisite: Nil
Total Hours: 42

Module 1: (10 hours)

Module 2: (12 hours)

Module 3: (10 hours)
Probability Plotting and Frequency Analysis – graphical and mathematical methods for construction of probability paper, probability plotting, analytical hydrologic frequency analysis, regional frequency analysis, frequency analysis of precipitation data and other hydrologic variables. Linear and nonlinear regression, transformation of nonlinear models. Correlation, correlation and regional analysis. Multivariate analysis, principal component analysis, univariate and multivariate data generation.

Module 4: (10 hours)
Hydrologic time series – definition, autocorrelation, spectral analysis, applications of autocorrelation and spectral density functions in hydrology. Stochastic hydrologic models – purely random stochastic models, first order Markov process, first order Markov process with periodicity, higher order autoregression models, multisite Markov model, Markov chain models of hydrologic processes.

References
CE6522 HydraulicModelling

Prerequisite: Nil
Total Hours: 42

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Module 1: (10 hours)
Review of theoretical background required for hydraulic modelling – basic mathematics, hydraulics, and numerical techniques.

Module 2: (10 hours)
Development of physical models – dimensional analysis and principles of similitude, non-dimensional numbers employed in hydraulic modelling, tools and procedures.

Module 3: (11 hours)
Modelling of open channel systems, closed conduit systems and urban drainage systems. Environmental modelling of open channel systems.

Module 4: (11 hours)
Modelling of estuaries, coastal processes, nearshore structures, and hydraulics structures.

REFERENCES
3. Helmut Kobus and Gerrit Abraham, Hydraulic Modelling, Parey.
CE6523 Finite Element Method in Hydro Engineering

Prerequisite: Nil  
Total hours: 42

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Module 1: (10 hours)  
Review of Basic Equations of Fluid Mechanics and Pipe Network Analysis  
Continuity, momentum, and energy equations, non-viscous fluid flow, irrotational flow, velocity potential, stream function, Bernoulli’s equation, Navier-Stokes equation. Linear finite element analysis of pipe networks, total system of equations, boundary conditions, solution of system of equations, non-linear analysis of pipe networks, computer algorithms for linear and non-linear analyses.

Module 2: (12 hours)  
One Dimensional Flow Analysis  

Module 3: (10 hours)  
Potential Flow Analysis  
Euler’s equation of motion, stream function formulation, potential function formulation, finite element solution of groundwater flow and flow around a cylinder. Finite element solution of Navier-Stokes equations using stream function and vorticity formulation.

Module 4: (10 hours)  
Time Dependent Field Problems  
One dimensional diffusion equation, analytical integration technique, time domain integration techniques – Euler method and improved Euler method. Introduction to typical CFD packages.

References  
CE6524 Applied Hydraulic Modelling

Prerequisite: Nil
Total Hours: 42

Module 1: (11 hours)
Conservation laws - mass, momentum and energy. Governing equations of fluid flow, initial and boundary conditions. Pipe flow - review of basic hydraulic principles of analysis and design of pipelines, losses in pipelines, pumping and gravity mains, economic analysis for pipe choice, pipe materials, specification for pipes, pipe appurtenances, design principles - internal pressures and external loads, analysis of distribution networks - Hardy Cross, equivalent pipe and Newton Raphson methods, computer applications in distribution network analysis, maintenance of distribution systems, methods of control and prevention of corrosion.

Module 2: (10 hours)
Pump-pipeline and turbine-pipeline systems. Transients in pipelines - causes, simple analysis by finite difference method and method of characteristics, transient control using surge tanks, air chambers and control valves.

Module 3: (10 hours)
Open channel flow - canal network and hierarchy of canals, afflux and energy loss, critical flow and uniform flow concepts, flow in erodible channels, channel design - design of erodible and lined channels for clear and sediment-laden flows - CBI & P method, tractive force method, regime methods. Gradually varied flow - classification and computation of profiles, compound channels, canal delivery problem, channel networks, spatially varied flow.

Module 4: (11 hours)
Rapidly varied flow - hydraulic jump, analysis of surges, design of spillways, energy dissipators, and channel transitions. Dam break analysis.

Main canal and flow distribution control, decentralised control, canal automation - purpose and selection of scheme, automation application, hardware and software components in automation systems, a typical automation system.

References
11. CBIP, Canal Automation.
CE6525 Hydrogeology and Groundwater Development

Prerequisite: Nil

Total Hours: 42

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Module 1: (10 hours)
Groundwater and the hydrologic cycle, problems and perspectives, arsenic and fluoride contamination of groundwater in India, groundwater balance, status of groundwater development – international and national scenarios, influence of physiography and climate on groundwater availability, major hydrogeologic formations in India.
Basic concepts of groundwater management, investigations and data collection, conjunctive use of surface and groundwaters, legal aspects of groundwater.

Module 2: (10 hours)
Basic geologic and hydrogeologic investigations including surface and subsurface investigations of groundwater, water divining/witching.
Types of wells, design and construction of open wells, open wells in alluvial and hard rock formations, failure of open wells, contamination and disinfection of open wells.

Module 3: (12 hours)
Types of tube wells, multiple well system, radial wells and infiltration galleries, design of tube wells - casing, bore size and depth, design of well screen and gravel pack, contamination of tube wells, failure of tube wells, rehabilitation of tube wells.
Construction of bored and driven tube wells – drilling equipment and methods, hand boring, mechanical percussion boring, direct and reverse circulation hydraulic rotary drilling, air rotary drilling, principles of rock drilling, drilling with foam, core drilling, calyx drilling, jetting. Installation of well screens and check for well alignment.
Well development and well completion.

Module 4: (10 hours)
Pumps used for lifting water - indigenous water lifts, positive displacement pumps, centrifugal pumps, vertical turbine pumps, submersible pumps, propeller and mixed flow pumps, jet pumps, air lift pumps, selection of pumps, power requirement, efficiency and economics.

References
CE6531  Environmental Impact Assessment of Water Resources Projects

Prerequisite: Nil
Total Hours: 42

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Module 1:(10 hours)

Module 2:(10 hours)
Steps in EIA such as screening, initial environmental examination (IEE), scoping, public participation. Environmental baseline studies. Impact assessment methods such as adhoc methods, checklists, matrices, quantitative methods, environmental indices, networks, overlay etc. Factors to be considered while assessing the impacts of projects related to water, wastewater, solid wastes etc.

Module 3: (10 hours)
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 of the MoEF regarding EIA of specific projects.

Module 4:(12 hours)

References
7. EIA manuals of the Ministry of Environment and Forests (MoEF), Government of India.
CE6532 Water Quality Modelling and Management

Prerequisite: Nil
Total Hours: 42

Module 1: (10 Hours)

Module 2: (12 Hours)

Module 3: (10 Hours)
Contaminant transport in unsaturated soil. Solute transport model for conservative species. Solute transport in spatially variable soil. Contaminant transport in groundwater, advection, dispersion, one dimensional transport with linear adsorption, dual porosity models, numerical models, biodegradation reactions.

Module 4: (10 Hours)

References
CE6533 Hydropower

Prerequisite: Nil
Total Hours: 42

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Module 1: (11 hours)

Module 2: (10 hours)
Run of the river plants, pumped storage plants. Mini and micro hydel plants. Tidal power plants. General arrangement of a power house, types of power houses.

Module 3: (10 hours)

Module 4: (11 hours)
Turbines and Generators. Flood routing through reservoirs and channels. Dam breach analysis. Cost and value of water power.

References
12. UNIDO, *Small Hydro Power Series*.
14. Journals
CE6534 Watershed Management

Pre-requisite: Nil
Total Hours : 42Hrs.

Module 1: (12 hours)

Module 2: (10 hours)

Module 3: (10 hours)

Module 4: (10 hours)

References
CE6535 Environmental Hydraulics

Prerequisite: Nil
Total Hours: 42

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<td>Fundamental relationships for flow and transport - general principles, instantaneous equation for fluid flow and transport, Reynold’s time-averaged mean flow and transport equations, model resolution, solution techniques, data requirements. Measurement and analysis of flow - measurement of velocity and flow, tracer studies, estimating design flows.</td>
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<td>Models for rivers and streams - Completely mixed systems - reaction kinetics, mass balance and steady state solution, particular solutions, feed-forward systems of reactors, feed-back systems of reactors, computer methods. Incompletely mixed systems - diffusion, distributed systems – steady and unsteady cases, steady state solutions, simple time variable solutions. BOD and oxygen saturation, Streeter-Phelps equation, point and distributed sources.</td>
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<td>Hydraulic analysis of various units in water treatment and wastewater treatment plants.Turbulent jets and plumes, ocean wastewater discharge systems.</td>
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REFERENCES
CE6541  IT Applications in Water Resources Engineering and Management

Prerequisite: Nil
Total Hours: 42

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Module 1: (11 hours)
Trends in information technology, artificial intelligence and knowledge based expert systems, parallel processing, applications.

Module 2: (11 hours)
Artificial neural network, genetic algorithms, fuzzy logic, applications.

Module 3: (10 hours)
Satellite remote sensing, geographical information system, global positioning system, applications.

Module 4: (11 hours)
Use of multimedia, web based engineering analysis and modelling, virtual reality, applications.

References
14. Journals
CE6542 Urban Hydrology and Drainage

Prerequisite: NIL

Total Hours: 42 Hrs.

Module 1: (11 hours)

Module 2: (11 hours)

Module 3: (10 hours)
Design of storm water drainage structures – Drainage design for street pavements – Storm sewer systems – Culverts – Surface drainage channels
Urban flooding and associated issues – Detention basins – Stage-discharge relationship - Detention basin design - Infiltration structures - Infiltration basins, Trenches

Module 4: (10 hours)
Storm water quality control - Concepts of BMPs and LID – Advantages – Computer models for urban storm water modelling – Public domain packages HEC-HMS, HEC-GeoHMS, EPA-SWMM.

References
Module 1:(11 hours)
Coastal Engineering – coastal environment and coastal zone, problems Water level fluctuations – tides, surges and seiches.
Introduction to Wave Mechanics – wave generation, small amplitude wave theory - formulation and solution, wave celerity, length and period, classification of waves based on relative depth, orbital motions and pressure, standing waves, wave train and wave energy. Wave transformation – shoaling, reflection, refraction and diffraction, Breaking of waves.

Module 2:(11 hours)
Finite Amplitude Waves – higher order wave theories such as Stokes wave theory, Cnoidal wave theory, trochoidal wave theory, solitary wave theory, and stream function wave theory. Numerical wave theory. Wave interaction with currents. Regimes of application of different wave theories. Tsunamis.
Short term and long term wave statistics. Sea as a stationary random process - wave spectral density, mathematical spectrum models.
Wind generated waves – wave forecasting and wave hindcasting.

Module 3:(10 hours)
Wave force on a circular (vertical, inclined and oscillating cylinder) - Morison Equation, wave force on submarine pipelines.

Module 4:(12 hours)
Coastal processes - long term and short term changes in the shoreline, cross shore and long shore currents, onshore-offshore movement of sediments, longshore transport, application of mathematical models, factors affecting equilibrium of beaches, coastal erosion and protection along the Kerala coast.
Integrated coastal zone management - resource planning and management, goals and purposes, sustainable use of resources, application of IT. Coastal ecosystems including mangroves. Mudbanks. Legislation in India pertaining to the coastal zone.

References
5. Dominic Reeve, Andrew Chadwick, and Christopher Fleming, Coastal Engineering, Spon Press.
CE6544  Pollution Science

Prerequisite: Nil
Total Hours: 42

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Module 1: (10 hours)

Module 2: (12 hours)

Module 3: (10 hours)
Pollution and mitigation of pollution of soil and land, and ground and surface waters. Fertilizers, pesticides and sediments as a source of pollution. Atmospheric Pollution. Global atmospheric changes. Introduction to global warming and climate change.

Module 4: (10 hours)
Solid waste treatment and disposal, municipal wastewater treatment, land application of biosolids and animal wastes. Drinking water treatment and water security. Environmental Management.

References
CE6545  Geographical Information Systems and Its Applications in Hydrology

Prerequisite: NIL
Total Hours: 42 Hrs.

Module 1: (11 hours)

Module 2: (11 hours)

Module 3: (11 hours)

Module 4: (9 hours)

References