**CENTRE FOR WATER RESOURCES**

**INSTITUTE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD**

**M.Tech (Water and Environmental Technology), COURSE STRUCTURE AND SYLLABUS (CBCS) -2019**

**SEMESTER-I**

PROGRAMME CORE-I / WET- 01

**SURFACE WATER HYDROLOGY**

**COURSE OUTCOMES**

The student is expected to

**CO1:** To learn about precipitation and its measurement, analysis and interpretation.

**CO2:** Know about abstractions to rainfall, infiltration, evaporation and transpiration along with their estimation and derivation of unit hydrograph from hydrograph.

**CO3:** Gain Knowledge about floods, its estimation, combat floods and flood routing.

**CO4:** Familiarize with surface water pollution, causes, effects and remedial measures.

**CO5:** Acquire knowledge about disasters and its management, conservation of water and climate change and its impact on water resources.

PROGRAMME CORE-II/WET-02

**GROUND WATER HYDROLOGY**

**COURSE OUTCOMES**

The student is expected to

**CO1:** To understanding the fundamentals concepts of groundwater for its storage movement governing laws with field and laboratory estimation of hydraulic properties.

**CO2:** Derivation of flow of Water through porous media its governing equations and estimation of aquifer parameters with various types of pumping tests in tube wells and open wells.

**CO3:** Application of ground water exploration techniques by using geophysical methods such as electrical resistivity methods and seismic refraction method to explore groundwater.

**CO4:** Practicing various groundwater management techniques such as artificial recharge, conjunctive use basin management and control of sea water intrusion.

**CO5:** To understand the groundwater pollution, remediation and modeling of the aquifer with respect to flow model and transport model.

PROGRAMME ELECTIVE –I/ WET-03

**ADVANCED FLUID MECHANICS**

**COURSE OUTCOMES**

The student is expected to

**CO1:** Inculcate knowledge on description of fluid motion, stream and velocity potential, their properties and applications.

**CO2:** Develop understanding on the dynamics of Ideal fluids, applications to one dimension problems and evaluate the problems on pipe bend, venturimeter and orifice meter.

**CO3:** Imbibe the equations of real fluids like Navier Stokes equation, Stokes flow and Hagen Poiseuille flow.

**CO4:** Acquire knowledge on boundary layer flow for various expressions and equation on laminar and turbulent boundary, Integral momentum and boundary layer separation.

**CO5:** Grasp the basic idea of turbulence in fluid flow.

PROGRAMME ELECTIVE –I/ WET-03

**WATER QUALITY MODELLING AND MANAGEMENT**

**COURSE OUTCOMES**

The student is expected to

CO1: Become familiar with water quality standards, contamination of water along with contaminant transport mechanism.

CO2: Know about sources of water, water quality models and eutrophication.

CO3: Gain knowledge about solute transport models and contaminant transport in unsaturated flows.

CO4: Learn about different mechanisms like advection, dispersion and different models like dual porosity model and numerical models.

CO5: Acquire knowledge about water quality management, control including groundwater remediation

PROGRAMME ELECTIVE –I/ WET-03

**ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY**

**COURSE OUTCOMES**

The student is expected to

**CO1:** Develop an understanding of structure and formation of an ecosystem.

**CO2:** Gain knowledge on energy flow and to understand biogeochemical cycles and their significance in the sustainability ecosystems.

**CO3:** Gain competency and understanding of the significance of chemical and biological reactions in environmental problems.

**CO4:** Identify domestic waste, household, community waste disposals and also to familiarize with chemistry of pesticides, insecticides, herbicides, detergents, and rodent control chemicals.

**CO5:** Acquire knowledge on soil, air, aquatic, domestic water and sewage, foods, milk and industrial microbiology.

PROGRAMME ELECTIVE –II/ WET-04

**WATER RESOURCES SYSTEMS ANALYSIS**

**COURSE OUTCOMES:**

The student is expected to

CO1: To develop objective function and constraints for various water resources optimization problems.

CO2: To develop linear programming models for water resources problems by using graphical and simplex and revised simplex techniques, to carry out sensitivity analysis and post optimality analysis.

CO3: To develop and solve forward and backward recursive dynamic programming models.

CO4: To understand optimization and simulation concepts and modeling and also apply simulation techniques in water resources problems.

CO5: To understand the fundamentals of economic theory as applied to water resources.

PROGRAMME ELECTIVE –II/ WET-04

**RIVER BASIN MANAGEMENT**

**COURSE OUTCOMES**

The student is expected to

**CO1:** To learn know about forecast of river flows, routing the flow and river confluences.

**CO2:** To understand river confluences and its balance, reservoir routing and aggregation of water users.

 **CO3:** Be familiar with management of different irrigation structures, water conservation and concerned technological innovations.

**CO4:** Have thorough understanding of judicious water allocation for various purposes and reservoir operation.

**CO5:** Gain knowledge about soil erosion and sedimentation, control measures and catchment treatment.

PROGRAMME ELECTIVE –II/ WET-04

**AIR POLLUTION AND CONTROL TECHNOLOGIES**

**COURSE OUTCOMES**

The student is expected to

**CO1:** The student is expected to understand the effects of air pollutants, the metrological aspects, plume behavior and atmospheric dispersion equation.

**CO2:** Acquire knowledge on sampling techniques and analyze air quality.

**CO3:** Understand and analyze the basic mechanisms involved, working principle and design aspects of various air pollution controlling equipments.

**CO4:** Identify the methods to control sulphurdioxide and nitrogen oxide emissions.

**CO5:** Gain knowledge on vehicular emissions and auto mobiles pollution control at sources along with legal measures.

LAB 1/ WET -05

**HYDROLOGY LABORATORY**

**COURSE OUTCOMES**

Students are expected to

CO1: Explore the groundwater using electrical resistivity and seismic methods.

CO2: Identify civil utility using Ground Penetrating Radar.

CO3: Determine of aquifer characters using pumping tests and well logging techniques.

CO4: Study the characteristics curves and specific energy curves.

CO5: Determine the frictional losses, coefficient of discharge and surface profiles coordinates.

LAB 2/ WET -06

**ENVIRONMENTAL LABORATORY**

**COURSE OUTCOMES**

Students will be able to

CO1: Perform common environmental experiments relating to water and wastewater quality, and know which tests are appropriate for given environmental problems.

CO2: Statistically analyze and interpret laboratorial results.

CO3: Understand and use the water and wastewater sampling procedures and sample preservations.

CO4: Demonstrate the ability to write clear technical laboratorial reports.

CO5: Understand the impact of biological parameters on wastewater.

CORE/ WET-07

**RESEARCH METHODOLOGY AND IPR**

**COURSE OUTCOMES:**

Students will be able to

CO1: Understand research problem formulation.

CO2: Analyze research related information

CO3: Follow research ethics

CO4: Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

CO5: Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

CO6: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

AUDIT COURSE -1/ WET -08

**ENGLISH FOR RESEARCH PAPER WRITING**

**COURSE OUTCOMES:**

Students will be able to:

CO1: Understand that how to improve your writing skills and level of readability

CO2: Learn about what to write in each section

 CO3: Understand the skills needed when writing a Title

 CO4: Ensure the good quality of paper at very first-time submission

AUDIT COURSE -1/ WET -08

**DISASTER MANAGEMENT**

**COURSE OUTCOMES:**

Students will be able to:

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4: Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

AUDIT COURSE -1/ WET -08

**SANSKRIT FOR TECHNICAL KNOWLEDGE**

**COURSE OUTCOMES:**

Students will be able to

CO1: Understand basic Sanskrit language.

CO2: Understand Ancient Sanskrit literature about science & technology.

CO3: Develop logic in students being a logical language.

AUDIT COURSE -1/ WET -08

**VALUE EDUCATION**

**COURSE OUTCOMES:**

Students will be able to

CO1: Gain knowledge of self-development

CO2: Learn the importance of Human values

CO3: Develope the overall personality

PROGRAMME CORE-III/WET-09

**GEOSPATIAL APPLICATIONS IN WATER RESOURCES**

**COURSE OUTCOMES**

The Student is expected to

CO1: Develop the knowledge on basic concepts of remote sensing, elements involved in remote sensing, its energy sources and interaction with earth’s surface features and foundations of remote sensing.

CO2: Comprehend the concepts of Geographical Information System (GIS), components of GIS, types and data structures.

CO3: Understand how the data sets are acquired and developed, and can carry out the preprocessing of data inputs.

CO4: Improve the learning on global positioning system (GPS), factors influencing GPS, GPS signal characteristics, mathematical model and GPS applications.

CO5: Identify the importance of Remote sensing and GIS in various applications like water resources, drought assessment, flood plain zoning etc.

PROGRAMME CORE-IV/WET-10

**WATER AND WASTEWATER TREATMENT TECHNOLOGIES**

**COURSE OUTCOMES:**

The student is expected to

CO1: Learn about water transmission pipe networks, non-revenue water and wastewater treatment as a part of water conservation.

CO2: Understand different water wastewater treatment units and its stages and design of water treatment plant.

CO3: Know about sewerage systems, design and appurtenances.

CO4: Gain knowledge about secondary or biological treatment of waste water sludge treatment and disposal, low cost waste treatment systems like oxidation pond and oxidation ditch.

CO5: Know about ecological sanitation and wetlands and its role in the treatment of wastewater, constructed wetlands, recycle and reuse of treated wastewater.

PROGRAMME ELECTIVE-III/WET-11

**FLUVIAL HYDRAULICS**

**COURSE OUTCOMES**

The student is expected to

CO1: To learn about types of flows and flow profiles, varied flow analysis and computation.

CO2: Understand dam break analysis, formation of jump on sloping channels, surges and its types.

CO3: Know about different methods of dimensional analysis and its applications.

CO4: Gain knowledge about different dimensionless members and their model laws and flow fields in which they are applicable, kinds of similarity and types of models and scale effect.

CO5: Be thorough with design of alluvial channels, different theories and their relative merits and demerits.

PROGRAMME ELECTIVE-III/WET-11

**URBAN HYDROLOGY**

**COURSE OUTCOMES**

The student is expected to

CO1: To know about impact of urbanization on urban runoff urban water sub systems, urban hydrologic cycle.

CO2: Learn modeling of storm water, probabilistic and statistical approaches of analysis of storm water data.

CO3: Understand urban drainage systems, sewers, components, design considerations, infiltration and exfiltration in sewers, field investigations and control measures.

CO4: Be well acquainted with storm water management, monitoring run off, quantity and quality, measures to mitigate damaging effects of urban storm runoff.

CO5: Be familiar with maintenance of urban drainage systems, pump stations, illicit connections, limitations and regulations.

PROGRAMME ELECTIVE-IV/WET-12

**SUSTAINABLE WATER RESOURCES DEVELOPMENT**

**COURSE OUTCOMES**

The student is expected to

**CO1:** To know about frame work for sustainable development of water Resources keeping global water crises in view.

**CO2:** To learn virtual water, national water policy, national water mission along with the challenges in the development of sustainable development of water resources.

**CO3:** To be thorough sustainable water resources management in local, regional and global perspective including the challenges to achieve sustainable water use and management.

**CO4:** To gain knowledge regarding water economics, options for water conservation and private sector involvement in water resources management.

**CO5:** To be well versed with water act, government policies on water conservation and the measures for sustainable water resources.

PROGRAMME ELECTIVE-IV/WET-12

**ENVIRONMENTAL IMPACT ASSESSMENT**

**COURSE OUTCOMES**

The Student is expected to

CO1: Understand the basic concept of EIA, important steps in EIA and systematic approach for using EIA as a planning Tool for Major project activities.

CO2: Identify the EIA methodologies and criteria for selection of EIA methodology.

CO3: Recognize the impact of development activities and landuse on soil and groundwater resources and assess the impact significance on landfills and human habitation.

CO4: Identify and interpret the projects which create impacts on surface water environment, surface water quality, Impact significance on water resources project.

CO5: Understand the concept of environment audit, its objective, different types of audit and experience on site activities and gain technical knowledge during the field visit to industries.

PROGRAMME ELECTIVE-IV/WET-12

**CLIMATE CHANGE ADAPTATION AND MITIGATION**

**COURSE OUTCOMES**

The Student is expected to

CO1: Understand the basic concept of climate change and its impacts on earth and India.

CO2: Evaluate the climate risk for different sectors.

CO3: Develop an adaptation plan for various sectors and prioritize the measures based on impact and cost-benefit analysis.

CO4: Propose mitigation measures, carry out carbon emission reduction and cost benefit analysis.

CO5: Understand the international and national policies on climate change along with sources of finance for implementing CCA and CCM measures.

LAB 3/WET-13

**GIS AND IMAGE PROCESSING LABORATORY**

**COURSE OUTCOMES**

 The Student is expected to

CO1: Identify and generate different types of maps using GIS software.

CO2: Prepare the maps for the delineated catchment area using GIS.

CO3: Carry out geometric correction of satellite data using ground control points (GCPs), and preparing mosaics of satellite images.

CO4: Generate Digital Elevation Models (DEM) and NDVI from satellite image of AOI.

CO5: Prepare Land use/land cover maps using unsupervised and supervised classification algorithms.

LAB 4/WET-14

**WATER RESOURCES MODELLING LABORATORY**

**COURSE OUTCOMES:**

The Student is expected to

CO1: Apply the concept of geomatics for watershed analysis and rainfall-runoff modelling using SWAT.

CO2: Execute evapotranspiration modeling using CROPWAT.

CO3: Identify harvesting structures in given area.

CO4: Priority watershed maps, flood maps including inundated areas, Surface water body maps, drought maps and their analysis.

CO5: Design the pipe distribution network and model the groundwater resources.

CORE/WET-15

**MINI PROJECT**

**COURSE OUTCOMES:**

CO1: Students will get an opportunity to work in actual industrial environment if they opt for internship.

CO2: In case of mini project, they will solve a live problem using software/analytical/computational tools.

CO3: Study different techniques used to analyze complex systems

CO4: Students will learn to write technical reports.

CO5: Students will develop skills to present and defend their work in front of technically qualified audience.

AUDIT COURSE-2/WET-16

**CONSTITUTION OF INDIA**

**COURSE OUTCOMES:**

Students will be able to:

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3: Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO4: Discuss the passage of the Hindu Code Bill of 1956.

AUDIT COURSE-2/WET-16

**PEDAGOGY STUDIES**

**COURSE OUTCOMES:**

Students will be able to understand:

CO1: What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?

CO2: What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?

CO3: How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

AUDIT COURSE-2/WET-16

**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**

**COURSE OUTCOMES:**

Students will be able to

CO1: Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

CO2: The person who has studied Geeta will lead the nation and mankind to peace and prosperity

CO3: Study of Neetishatakam will help in developing versatile personality of students.

PROGRAMME ELECTIVE –V/WET-17

**SOLID AND HAZARDOUS WASTE MANAGEMENT**

**COURSE OUTCOMES**

The student is expected to

CO1: To know about solid and hazardous waste transportation, environmental laws and analysis of hazardous waste.

CO2: Learn waste recovery processes, cradle to grave concept of handling hazardous waste.

CO3: Understand disposal of hazardous waste both on surface and underground and waste minimization and hazardous waste remediation technologies.

CO4: Be familiar with collection transportation treatment and safe disposal of both biological and electronic waste and be conversant with reuse and recycling of wastes, recovery of by products and energy audit.

CO5: Gain knowledge about waste land characteristics and its remediation, different kinds of pollution of soils, remediation methods.

PROGRAMME ELECTIVE –V/WET-17

**HYDRO POWER DEVELOPMENT**

**COURSE OUTCOMES**

The student is expected to

CO1: To know about hydropower systems, types, different load studies, pondage and storage.

CO2: Understand different intake structures, layout of a hydropower plant, penstock, design and anchorages.

CO3: Learn about water hammer, analysis, solution of linearized equations.

CO4: Be familiar with surge tanks, types, working, computations and stability analysis.

CO5: Be well acquainted with power houses, arrangement, selection of type, criteria for fixing dimensions, layout of underground power houses, stability and merits.

PROGRAMME ELECTIVE –V/WET-17

**MICRO IRRIGATION TECHNOLOGIES**

**COURSE OUTCOMES:**

The student is expected to

CO1:The design of an irrigation system.

CO2:Know about design of drip and sprinkler irrigation systems.

CO3:Understand the concepts of land scaping.

CO4:Gain knowledge on automation and fertigation.

CO5:Familiarize with operation and maintenance of irrigation systems.

OPEN ELECTIVE/WET-18

**BUSINESS ANALYTICS**

**COURSE OUTCOMES:**

 Students will be able to

CO1: Demonstrate knowledge of data analytics.

CO2: Think critically in making decisions based on data and deep analytics.

CO3: Use technical skills in predicative and prescriptive modeling to support business decision-making.

CO4: Translate data into clear, actionable insights.

OPEN ELECTIVE/WET-18

**OPERATIONS RESEARCH**

**COURSE OUTCOMES:**

The student should be able to

CO1: Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.

CO2: Students should able to apply the concept of non-linear programming

CO3: Students should able to carry out sensitivity analysis

CO4: Student should able to model the real world problem and simulate it.

OPEN ELECTIVE/WET-18

**ENVIRONMENTAL STATISTICS**

**COURSE OUTCOMES**

The Student is expected to

CO1: Understand the data, sampling procedures, descriptive and inferential statistics in environmental data

CO2: Use R and MS Excel for basic statistical analysis for environmental data

CO3: differentiate discrete and continuous probabilities and its application in environmental science, carry out various test and hypothesis

CO4: use correlation, regression and analysis of various in R and Excel for interpreting environental data and use it for decision making

CO5: Understand the concept of spatial statistics and use it for environmental data for decision making

**DISSERTATION PHASE-1**

**COURSE OUTCOMES:**

**CO1:** Students will be exposed to self-learning various topics.

**CO2:** Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.

**CO3:** Students will learn to write technical reports.

**CO4:** Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience.

**DISSERTATION PHASE- II**

**COURSE OUTCOMES:**

CO1: Students will be able to use different experimental techniques.

CO2: Students will be able to use different software/ computational/analytical tools.

CO3: Students will be able to design and develop an experimental set up/ equipment/test rig.

CO4: Students will be able to conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.

CO5: Students will be able to either work in a research environment or in an industrial environment.

CO6: Students will be conversant with technical report writing.

CO7: Students will be able to present and convince their topic of study to the engineering community.