Aquatic Environmental Management				
Courses Offered (V Dean)				
Sr.	**Semester**	**Course No.**	**Title**	**Credits**
1.	**I**	**AEM.111**	**Meteorology, Climatology and Geography**	**1+1=2**
	Lecture	***THEORY :***		
	1	Nature of Atmosphere: weather and climate;		
	2	Composition of atmosphere;'structure of atmosphere.		
	3	Heat energy of atmosphere: process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of atmosphere		
	4	Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature		
	5	Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements.		
	6	Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India.		
	7	Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms		
	8	Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients.		
	9	Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze.		
	10	Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning.		
	11	Weather forecasting: forecasting process; forecasting from local indications;		
	12	Role of satellite in weather forecasting; synoptic weather charts		
	13	Effects of climate change on fisheries sector		
	14	Introduction to Geography; shape, size and structure of the earth		
	15	Concepts of latitude, longitude, and great circles		
	16	Model globe, maps and different types of projections; cartography; landscape		
		PRACTICAL:		
	1	***Meteorology:*** Graphic representation of structure of atmosphere; physical layering and compositional layering.		
	2	Temperature instruments: simple thermometers; six's Max-Min Thermometer; thermograph.		
	3	Isotherms: world mean temperatures-January to July. India mean temperatures - January to July.		
	4	Humidity measurement: hygrometer; psychrometer; relative humidity; dew point.		

	5-6	Condensation: observation and identification of various types of clouds.		
	7	Precipitation: measurement of rainfall using rain gauge.		
	8	Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets-		
	9	Atmospheric pressure measurement: fortin's mercurial barometer; Aneroid barometer.		
	10	Isobars; India mean pressure - Jan to July.		
	11	Wind observation and measurement: wind vane; cup anemometer.		
	12	Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation.		
	13	***Geography:*** The Earth: diagrammatic representation of shape, size, structure,		
	14	Zones, latitudes, longitudes and great circles.		
	15	Typical landscape mapping; map reading.		
	16	Geographical terms used in landscape-		
2.	**I**	**AEM.112**	**Soil and Water Chemistry**	**2+1=3**
	Lecture	***THEORY :***		
	1	Analytical chemistry: principles, applications and types.		
	2	Classical methods of analytical chemistry, volumetry and gravimetry.		
	3	Solutions: Standard solutions, titration, indicators, dilute solutions,		
	4	Units of concentration: standard curve; nomogram.		
	5	Chemistry of water: the water molecule, properties of pure water, fresh water and sea water.		
	6	Composition of waters: surface water, ground water and sea water.		
	7	Dissolved gasses: Factors affecting natural waters.		
	8-9	Acid, base, salts: Hydrogen ions, modern concept of pH and buffer.		
	10	Water analysis: collection and preservation of water samples.		
	11	Measurement of temperature. transparency, turbidity,		
	12	Determination of pH, electrical conductivity, salinity, chlorinity,		
	13	Total solids (TDS, TSS, TVS, TVDS),		
	14	Dissolved oxygen, free carbon dioxide, total alkalinity,		
	15	Total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus.		
	16	Water quality criteria/ requirements for Aquaculture.		
	17	Soil Chemistry: origin and nature of soils.		
	18-19	Physical properties of soil; soil colour. texture, structure, pore size, bulk density, water holding capacity.		
	20	Soil types and their distribution.		
	21-22	Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility.		
	23	Soil reaction: acidity, alkalinity, conductivity, redox - potential.		
	24	Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation.		
	25-27	Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation.		
	28	Soil analysis: collection and preparation of soil samples.		
	29	Determination of soil texture, water holding capacity, pH, conductivity, organiccarbon, nitrogen, phosphorus, lime requirement.		
	30	Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum.		

	31	Environmental ameliorative: chlorination, deodorizers, bacterial formulation.		
	32	Soil quality criteria/ requirements for aquaculture.		
		PRACTICAL:		
	1	Principles of Titrimetry, Gravimetry,		
	2	Principles of Potentiometry, Conductometry, Refractometry,		
	3	Principles of Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system.		
	4	Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis.		
	5	Water analysis: measurement of temperature, turbidity,		
	6	Determination of pH and EC.		
	7	Determination of salinity, Chlorinity,		
	8	Determination of Total solids, Redox potential,		
	9	Determination of DO,		
	10	Determination of Free CO_2.		
	11	Determination of total alkalinity, hardness.		
	12	Determination of inorganic nitrogen, and phosphorus.		
	13	Soil analysis: Determination of soil texture, soil pH,conductivity,		
	14	Determination of soil available nitrogen,		
	15	Determination of soil available phosphorus,		
	16	Determination of organic carbon.		
3.	**II**	**AEM.123**	**LIMNOLOGY**	**2+1=3**
	Lecture	***THEORY :***		
	1	Introduction to limnology: inland water types, their characteristics and distribution		
	2	Ponds and lakes; streams and rivers; dynamics of lentic and lotic environments.		
	3-4	Lakes their origin and their diversity: famous lakes of the world and India;		
	5-8	Nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence ofphysical and chemical conditions on living organisms in inland waters		
	9-13	Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity		
	14-15	Aquatic plants: characterstics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role		
	16	Nekton: distribution, movements.		
	17	Benthos: classification; periphyton; zonation;		
	18	Distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna		
	19-23	Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment.		
	24-27	Lotic environments: running waters in general; physical conditions;		

	28-32	classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.		
		PRACTICAL :		
	1-5	Determination of physical characteristics of lentic and lotic water bodies		
	6-9	Determination of chemical characteristics of lentic and lotic water bodies.		
	10-12	Collection and identification of fresh water phytoplankton Enumeration and biomass estimation of freshwater phytoplankton. Estimationof primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton.		
	13-14	Collection and identification of benthos from lakes and ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquaticplants from different fresh water bodies		
	15-16	Field visit to lotic and lentic water bodies.		
4.	**II**	**AEM.124**	**MARINE BIOLOGY**	**2+1=3**
	Lecture	***THEORY :***		
	1-3	Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions.		
	4-6	Life in oceans - general account of major groups of phytoplankton and zooplankton groups.		
	7-8	General account of sea weeds,		
	9-10	Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide.		
	11	Vertical migration of zooplankton,		
	12	Phytoplankton-Zooplankton relationship,		
	13-14	Geographical and seasonal variation in plankton production,		
	15	Plankton and fisheries.		
	16-19	Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation.		
	20	Mud banks: formation, characteristics.		
	21-23	Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries.		
	24-25	Boring and fouling organisms.		
	26-28	Nekton outline, composition of nekton, habitats of nekton.		
	29-30	Bioluminescence and indicator species,		
	31	Blooms,		
	32	Red tides: cause and effects		
		PRACTICAL:		
	1-3	Study of common instruments used for collection of phytoplankton, zooplankton and benthos.		
	4-6	Collection, preservation and analysis of phytoplankton,		
	7-9	Collection, preservation and analysis of zooplankton,		
	10-12	Collection, preservation and analysis of sea weeds,		
	13-16	Collection preservation and analysis of inter tidal organisms.		

5.	**II**	**CNC.123**	**Democracy, Elections and Good Governance**	**1+0=1**
	Lecture	**THEORY :**		
	1-6	Democracy in India- Dimensions of Democracy: Social, Economic and Political; Decentralisation: Grassroots Level Democracy; Challenges before Democracy: women and marginalised sections of the society.		
	7-11	Election to Local Self Government Bodies-73rd and 74th Constitutional Amendment Acts: Institutions at the local level and Role of State Election commission; Local Body Elections: Urban & Rural; Duties of an Individual towards electoral process.		
	12-16	Good Governance – Meaning and concept; Government and Governance; Good Governance initiatives in India.		
6.	**III**	**AEM.215**	**Aquatic Ecology, Biodiversity and Disaster Management**	**2+1=3**
	Lecture	***THEORY :***		
	1	Aquatic environment, Flora and fauna: Components of aquatic systems,		
	2-4	Aquatic productivity, nutrient cycles, energy flow, food chain.		
	5	Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship.		
	6-8	Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices.		
	9	Ecological and evolutionary processes.		
	10-12	Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes.		
	13-14	Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries.		
	15-16	Conservation programmes for endangered species, *ex situ* and *in situ* conservation, captive breeding and management of endangered species.		
	17	Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.		
	18	***Disaster Management in Fisheries:***Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India.		
	19	Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing,		
	20	Introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters.		
	21-22	Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures.		
	23	During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices.		
	24	Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation.		

	25	Prevalent national and global management practices in disaster management.		
	26	Agencies involved in monitoring and early warnings at district, state, national and global levels.		
	27-28	Sea safety and health.		
	29	Acquaintance with fire-fighting devices.		
	30	Life saving appliances and first-aid.		
	31	Uses of distress signals and technologies.		
	32	Relief and rehabilitation measures, trauma counseling.		
		PRACTICAL:		
	1-2	Collection of species of fishes.		
	3-5	Collection of species other organisms		
	6-7	Studying the assemblages of organisms of rocky, sandy and muddy shores,		
	8-9	Studying the assemblages of organisms of lentic and lotic habitats.		
	10	Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation.		
	11-13	Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs.		
	14-16	Working out biodiversity indices.		
7.	**III**	**AEM.216**	**Fishery Oceanography**	**1+1=2**
	Lecture	***THEORY :***		
	1	Introduction to Oceanography: classification; World's major oceans		
	2	Expeditions national and international		
	3	Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans		
	4	Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves		
	5	Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction		
	6 - 10	Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino		
	11	Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater.		
	12	Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity		
	13	General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans.		
	14 -16	Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO2 system and alkalinity; inorganic agencies affecting composition of sea water		

		distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.		
		PRACTICAL :		
	1	Field visits & operation of oceanographic instruments- Nansen reversing water sampler, Reversing thermomete		
	2-3	Bathythermograph,		
	4	Grabs,		
	5-6	Corers,		
	7	Current meters,		
	8	Tidal gauges,		
	9	Echo-sounder.		
	10	Bottom topography of ocean		
	11-16	Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water		
8.	**V**	**AEM.317**	**Coastal Zone Management**	**1+1=2**
	Lecture	***THEORY :***		
	1	Estuaries, Wet lands and Lagoons, Living resources – Non living resources.		
	2-3	Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems.		
	4-5	Data Input, Data Management, Data Quality.		
	6-7	Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification.		
	8-9	Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations.		
	10	CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application and case studies.		
	11-12	Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM.		
	13	Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection.		
	14	Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry.		
	15	Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries.		
	16	Evaluation and Methodology; Social Impact Assessment and other developmental activities.		
		PRACTICAL:		
	1-5	Field visit to different coastal environments to study erosion of beaches,		
	6-8	Identification of ecologically sensitive areas and protection,		
	9	Study of CRZ, ICZM along the coastal belt,		
	10	Study on implementation and violation of CRZ,		
	11-13	Study of application of remote sensing and GIS,		
	14-16	Project preparation of EIA.		
9.	**VI**	**AEM.328**	**Aquatic Pollution**	**1+1=2**

	Lectures	*THEORY :*
	1	Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment,
	2	Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies.
	3	Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse.
	4	Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget;
	5	Biological effects of organic matter.
	6	Excessive plant nutrients: Eutrophication; Red tides and fish kills.
	7	Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs);
	8	Bioaccumulation and impact on aquatic fauna and human health; toxicology.
	9	Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation.
	10	Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies.
	11	Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex;
	12	Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion;
	13	Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution.
	14	Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India.
	15	Monitoring and control of pollution: Biological indicators of pollution.
	16	Solid waste management.
		PRACTICAL:
	1	Physical characteristics of polluted waters; Colour, Odour, Turbidity.
	2	Determination of pH, salinity, alkalinity, hardness,
	3	Determination of BOD, COD,
	4	Determination of Hydrogen sulphide, Phosphates, Ammonia, Nitrates,
	5	Determination of Heavy metals and Oil and grease in water.
	6	Determination of pH, conductivity,
	7	Determination of organic carbon, nitrogen, phosphorus,
	8	Determination of heavy metals in sediments.
	9	Study of pathogenic and coliform bacteria. Bacteriological quality of water; Colliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters.
	12	Pollution flora and fauna: indicator species- algae, protozoa and insect larva.
	13-14	Methods of pesticide residue analysis in waters and fish tissue;

	15-16	Bioassay and toxicity study.

Department of Aquatic Environment Management				
Courses Offered (VI Dean)				
Sr.	**Semester**	**Course No.**	**Title**	**Credits**
1.	**I**	**AEM.111**	**Soil and Water Chemistry**	**1+1=2**
	Lecture	***THEORY :***		
	1-4	Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry.		
	5-9	Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve, nomograph.		
	10-12	Chemistry of water: the water molecule, properties of pure water, fresh water and sea water.		
	13-14	Composition of waters: surface water, ground water and sea water.		
	15	Dissolved gasses: Factors affecting natural waters.		
	16	Acid, base, salts, Hydrogen ions, modern concept of pH and buffer.		
	17	Water analysis: collection and preservation of water samples.		
	18-20	Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus.		
	21	Water quality criteria/ requirements for Aquaculture.		
	22	Soil Chemistry: Origin and nature of soils.		
	23	Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity.		
	24	Soil types and their distribution.		
	25	Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility.		
	26	Soil reaction: acidity, alkalinity, conductivity, redox - potential.		
	27	Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation.		
	28	Saline soils, Alkali soils, acid sulphate soils, iron pyrites, and soil reclamation.		
	29	Soil analysis: collection and preparation of soil samples, determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement.		
	30	Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum.		
	31	Environmental ameliorative: chlorination, deodorizers, bacterial formulation.		
	32	Soil quality criteria/ requirements for aquaculture		
		PRACTICAL:		

	1-3	Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system.		
	4	Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis.		
	5-7	Water analysis: measurement of temperature, turbidity, determination of pH and EC.		
	8-11	Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO2 .		
	12	Determination of total alkalinity, hardness.		
	13	Determination of inorganic nitrogen, and phosphorus.		
	14-16	Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.		
2.	**I**	**AEM.112**	**Meteorology and Geography**	**1+1=2**
	Lecture	***THEORY :***		
	1	Nature of Atmosphere: weather and climate.		
	2	Composition of atmosphere; structure of atmosphere.		
	3	Heat energy of atmosphere: the process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of the atmosphere.		
	4	Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature.		
	5	Humidity and water vapour: the relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements. atmosphere; evaporation.		
	6	Condensation and precipitation: process of conditions of condensation, forms of condensation.		
	7	Precipitation; forms of precipitation, measurement of precipitation; rainfall in India.		
	8	Clouds and thunderstorms: amount of cloudiness; ceiling; lassification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms.		
	9	Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units;pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients.		
	10	Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion.		
	11	Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze.		
	12	Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning.		

	13	Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts.		
	14	Effects of climate change on fisheries sector.		
	15	Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles.		
	16	Model globe, maps and different types of projections; cartography; landscape.		
		PRACTICAL:		
	1	Site selections for meteorological observatory		
	2	Plan layout of meteorological observatory		
	3	Graphic representation of the structure of atmosphere; physical layering and compositional layering.		
	4-5	Temperature instruments: simple thermometers; six's Max-Min Thermometer; thermograph.		
	6	Humidity measurement: hygrometer; psychrometer; relative humidity; dew point.		
	7	Precipitation: measurement of rainfall using rain gauge.		
	8-9	'Atmospheric pressure measurement: Fortin's mercurial barometer; Aneroid barometer.		
	10-11	Wind observation and measurement: wind vane; cup anemometer.		
	12-13	Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets-		
	14	Geography: The Earth: diagrammatic representation of shape, size, structure.		
	15	Zones, latitudes, longitudes and great circles.		
	16	Geographical terms used in landscape.		
3.	**I**	**SEC.112**	**Analytical Techniques (Testing of Water, Soil, Feed etc.)**	**0+2=2**
		PRACTICAL:		
	1-3	Visit to freshwater bodies in nearby area		
	4-5	Site selection for water and soil collection		
	6-7	Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis.		
	8-11	Chemical preparation for water and soil analysis		
	12-13	Collection and preservation of water and soil samples		
	14	Analysis of Dissolved oxygen		
	15	Analysis of free carbon dioxide		
	16	Measurement of temperature and transparency, and turbidity,		
	17-18	Determination of pH, electrical conductivity, salinity, and chlorinity,		
	19	Measurement of total solids (TDS)		
	20	Measurement of total alkalinity		

	21	Measurement of Total hardness		
	22	Measurement of Nitrate and Nitrite		
	23-24	Measurement of Ammonia and phosphorus		
	25-27	Study Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity etc		
	28-30	Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus etc.		
	31-32	Analysis of biochemical composition of feed		
4.	**II**	**AEM.123**	**Limnology**	**1+1= 2**
	Lecture	***THEORY :***		
	1	Introduction to limnology: inland water types, their characteristics and distribution		
	2	Ponds and lakes; streams and rivers; dynamics of lentic and lotic environments.		
	3.4	Lakes - their origin and diversity. Famous lakes of the world and India		
	5-6	Nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters.		
	7	Classification of lakes, thermal stratification in lakes		
	8-9	Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms;		
	9	Aquatic plants: characteristics, classification, zonation, &limnological role.		
	10-11	Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna		
	12-13	Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics;		
	14	successional phenomena; indices of productivity of lakes; artificial enrichment		
	15-16	Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.		
		PRACTICAL:		
	1	Field visit to lotic and lentic water bodies		
	2-5	Determination of physical & chemical characteristics of lentic and lotic environment		

	6-8	Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton		
	9-11	Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton.		
	11-13	Collection and identification of aquatic plants from different fresh water bodies.		
	14-15	Collection and identification of nekton/aquatic insects from freshwater bodies		
	16	Collection and identification of benthos from lakes and ponds, streams, and canals.		
5.	**II**	**BSC.126**	**Environmental Studies and Disaster Management**	**3 (2+1)**
	Lecture	**THEORY :**		
	1-3	Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere.		
	4-6	Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources.		
	7-8	Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems.		
	9	Biodiversity and its conservation: Introduction, definition, types.		
	10-11	Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity.		
	12-14	Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (h) light pollution.		
	15-17	Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes.		
	18-19	Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management.		
	20-22	Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.		
	23-24	Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.		
	25-26	Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.		
	27-28	Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone,		

		earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves.		
	29-30	Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents.		
	31	International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management.		
	32	Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.		
		PRACTICAL		
	1	Visit to a local area to document environmental assets river/forest/grassland/hill/mountain.		
	2	Energy: Biogas production from organic wastes.		
	3	Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system.		
	4	Floral and faunal diversity assessment in polluted and un polluted system.		
	5-6	Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds.		
	7-8	Environmental sampling and preservation. Water quality analysis: pH, EC and TDS.		
	9	Estimation of Acidity, Alkalinity.		
	10-11	Estimation of water hardness. Estimation of DO and BOD in water samples.		
	12-13	Estimation of COD in water samples. Enumeration of E. coli in water sample.		
	14	Assessment of Suspended Particulate Matter (SPM).		
	15	Study of simple ecosystem – Visit to pond/river/hills.		
	16	Visit to areas affected by natural disaster.		
6.	**V**	**AEM.314**	**Aquatic Ecology and Biodiversity**	**1+1=2**
	Lecture	***THEORY :***		
	1	Aquatic environment, Flora and fauna: Components of aquatic systems.		
	2	Aquatic productivity, nutrient cycles, energy flow, food chain.		
	3-4	Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host-parasite relationship.		
	5-7	Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices		
	8	Ecological and evolutionary processes. Ecological niches		
	9-12	Lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes		
	13	Threats to aquatic biodiversity		
	14	Conservation of habitats: marine parks and sanctuaries		

	15	Conservation programs for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species.		
	16	Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices		
		PRACTICAL:		
	1-5	Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats		
	6-10	Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation		
	10-14	Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs.		
	15	Collection, identification, and preservation of aqutic plants.		
	16	Working out biodiversity indices		
7.	**VI**	**AEM.325**	**Coastal Zone Management**	**1+1=2**
	Lecture	***THEORY :***		
	1	Estuaries, Wet lands and Lagoons, Living resources – Non living resources.		
	2-3	Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems.		
	4	Data Input, Data Management, Data Quality.		
	5	Remote Sensing for Coastal Management.		
	6	Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management.		
	7	Applications of GIS in aquatic resource identification.		
	8	Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations.		
	9	CRZ mapping		
	10	Integrated Coastal Zone Management (ICZM); concept, application and case studies.		
	11-12	Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM.		
	13	Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection.		
	14	Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry.		
	15	Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries.		

	16	Evaluation and Methodology; Social Impact Assessment and other developmental activities.		
		PRACTICAL:		
	1	Field visit to different coastal environments to study erosion of beaches.		
	2	Identification of ecologically sensitive areas and protection.		
	3	Study of CRZ, ICZM along the coastal belt.		
	4	Study on implementation and violation of CRZ.		
	5	Study of application of remote sensing and GIS.		
	6-9	Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats.		
	10-11	Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation to combat disaster.		
	12-14	Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs.		
	15	Working out biodiversity indices.		
	16	Project preparation of EIA.		
8.	**VI**	**AEM.326**	**Marine Biology**	**1+1=2**
	Lecture	***THEORY :***		
	1-2	Introduction to Marine Biology: Divisions of marine environment-pelagic, benthic, euphotic, aphotic divisions and their subdivisions.		
	3-6	Life in oceans - general account of major groups of phytoplankton, zooplankton and seaweeds.		
	7-9	Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide.		
	10	Vertical migration of zooplankton.		
	11	Phytoplankton-Zooplankton relationship.		
	12-13	Geographical and seasonal variation in plankton production.		
	14	Plankton and fisheries.		
	15-19	Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation.		
	20	Mud banks: formation, characteristics.		
	21-22	Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries.		
	23-24	Boring and fouling organisms.		
	25-27	Nekton outline, composition of nekton, habitats of nekton.		
	28-29	Bioluminescence.		
	30	Indicator species.		
	31	Blooms.		
	32	Red tides: cause and effects.		
		PRACTICAL:		

	1-5	Study of common instruments used for collection of phytoplankton, zooplankton and benthos.		
	6-8	Collection, preservation and analysis of phytoplankton.		
	9-10	Collection, preservation and analysis of zooplankton.		
	11-16	Collection, preservation and analysis seaweeds and inter tidal organisms.		
	1-5	Study of common instruments used for collection of phytoplankton, zooplankton and benthos.		
	6-8	Collection, preservation and analysis of phytoplankton.		
	9-10	Collection, preservation and analysis of zooplankton.		
	11-16	Collection, preservation and analysis seaweeds and inter tidal organisms.		
9.	**VII**	**AEM.417**	**Fishery Oceanography**	**2+1=3**
	Lecture	***THEORY :***		
	1	Introduction to Oceanography. Different branches of Oceanography		
	2-3	Earth and the ocean basin, distribution of water and land;		
	4-6	Relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans.		
	7-10	Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity		
	11-12	Ocean Waves: definition and terms; classification. Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves.		
	12-14	General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram		
	15-17	Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction.		
	18-21	Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents, Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world.		
	22	El Nino and Southern Oscillation.		
	23-25	Water masses of Indian oceans.		
	26-30	Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO2 system and alkalinity; inorganic agencies affecting composition of sea water		

		distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.		
	31-32	Environmental factors influencing the seasonal variations in fish catch in the Arabian Sea and the Bay of Bengal.		
		PRACTICAL:		
	1	Study of ocean bottom topography		
	2	Study of on board accessories of oceanographic vessel		
	3	Study water transparency measuring device		
	4-5	Study of sub surface water temperature measurement devices) Reversing Thermometer, Bathythermograph,		
	6	Study of Nansen reversing bottle		
	7-10	Study of Bottom Sediment Collecting Device - Phleger corer ,Ekman Grab Peterson Grab, Lafond Dietz Snapper		
	11-14	Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water.		
	15-16	Use of tide tables. Fisheries forecasting systems. Oceanographic equipment and fish-finding devices		
10.	**VII**	**AEM.419**	**Aquatic Pollution**	**2+1=3**
	Lecture	***THEORY :***		
	1-2	Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment.		
	3-4	Classification of pollution; Physical, chemical and biological classification of water pollution- description of terminologies.		
	5-6	Sewage and domestic wastes; composition and pollution effects, sewage treatment and its reuse.		
	7-8	Agricultural wastes; organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand (BOD, COD), Oxygen budget;		
	9-10	Biological effects of organic matter. Excessive plant nutrients:		
	11	Eutrophication; Red tides and fish kills.		
	12-13	Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs);		
	14-16	Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms.		
	17	Bioremediation and Phytoremediation.		
	18-20	Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons;		

	21-23	Ecological Impact of Oil pollution - Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex;		
	24-26	Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion;		
	27-28	Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects,		
	29	Physical and chemical nature of possible effluents from major industries in India.		
	30-31	Monitoring and control of pollution: Biological indicators of pollution.		
	32	Solid waste management.		
		PRACTICAL:		
	1-7	Estimation of physio-chemical characteristics of polluted waters: Colour, Odour, Turbidity, pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphone, phosphates, ammonia, nitrates, nitrites, heavy metals and Oil and grease in water.		
	8-9	Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments.		
	10-11	Bacteriological tests of waste water: Coliform tests, IMVIC test, standard plate count.		
	12-13	Methods of enumerating bacterial biomass in waters and waste waters.		
	14-16	Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study.		
11.	**VII**	**AEM.411**	**Analytical Techniques in Aquatic Environmental Studies**	**2+1=3**
	Lecture	***THEORY :***		
	1-2	Qualitative and quantitative analytical techniques including Gravimetric and volumetric analyses used in environmental science,		
	3-4	Sampling techniques and procedures,		
	5-7	Factors affecting the choice of analytical techniques, Interferences and their minimization,		
	8	Laboratory safety measures.		
	9-15	Photometric techniques: Theory, instrumentation and application of spectrophotometry and spectroscopy, AAS, ICP-MS, Biosensor, Microscopic Techniques etc.		
	16-19	Theory and applications of electrophoresis, Principles and uses of ultra-centrifugation, Tracer Techniques, Isotopes in environmental analysis.		
	20-24	Separation techniques: Chromatography – theory, instrumentation and applications of thin layer, paper, ion-exchange, size exclusion, high performance liquid and gas chromatography.		

	25-27	Methods of preparing biological samples for chromatographic analysis GC-MS Unit. Bioanalysis techniques:		
	28-29	Immunoassay – Principle, methods and applications and Biosensors – components, characteristics, applications, impacts and challenges.		
	30-32	Nanotechnology: Preparation of nanoparticles, characterization and applications.		
	Practical	***PRACTICAL:***		
	1-3	Eutrophication studies in natural waters - tanks and ponds		
	4-5	Estimation of bio-indicator organisms in polluted waters.		
	6-7	Bioremediation experiments using different bio-agents.		
	8-11	Use of UVvisible Spectrophotometer for phosphate, nitrate other ions.		
	12-13	AAS for analysis of heavy metals.		
	14-16	Use of HPLC and GC-MS for analysis of pesticide and other volatile and semi volatile organic substances.		
12.	**VII**	**AEM.418**	**Climate Change and its Impact on Fisheries**	**2+0=2**
	Lecture	***THEORY :***		
	1-5	Weather and climate, Greenhouse effect, Radiative balance, Climatic migration, Carbon Sequestration and trading,		
	6-7	Projected trends of climate change and disasters		
	8-10	Climate change, its impacts, Aquatic ecosystem, Capture and culture fisheries,		
	10-12	Carbon footprint in fisheries and aquaculture.		
	13-16	Oceanographic factors in fisheries: Effects of physio-chemical and biological oceanographic factors on adaptation; Behaviour, abundance and distribution of aquatic organisms; Primary and secondary productivity in ocean under changing climate		
	17-20	Ocean acidification, Global Ocean circulation, Upwelling and circulation patterns, El Nino and Southern Oscillation,		
	21-24	IPCC and its reports, UNFCCC, Kyoto Protocol, and Politics of climate change.		
	25-28	Forecasting systems: Fisheries forecasts – Interpretation and use of ocean thermal structure; Fisheries forecasting system in India and other countries: Application of Remote sensing and GIS in fisheries; Application of echosounders and SONAR; Potential fishing zones.		
	29-32	Factors affecting marine fisheries. Adaptation and mitigation measures for Climate change; Vulnerability assessment; Climate-resilient aquaculture; Climate-smart villages		
13.	**VII**	**AEM.412**	**Aquatic Microbiology**	**1+1=2**
	Lecture	***THEORY :***		
	1-2	Distribution and classification: Microbial community in freshwater; Estuarine and marine environment (types and abundance).		
	3	Factors affecting microbial growth and abundance.		

	4	Microbial interaction: Microbial degradation of persistent organic pollutants (POPs).
	5-6	Microorganisms and public health: Water-borne pathogens of public health importance - Protozoans, bacteria, entero-viruses.
	7	Microbial toxins; Algal toxins.
	8	Disinfection methods; Microbial standards for different water uses.
	9-11	Principles and applications of bioprocesses: Bioremediation, Biofertilization, Biofilms, Biofloc, Probiotics, Bio-leaching, Bio-corrosion, Bio-fouling.
	12-13	Microorganisms as Bio indicators and Biosensors.
	14-15	Methods of assessing microbial biomass production; Bioprospecting: Current practices in bioprospecting and biopiracy.
	16	Microbial metabolites and its industrial application.
		PRACTICAL:
	1-5	Isolation, identification and enumeration of algae and bacteria from polluted aquatic habitats.
	6-9	Maintenance of algal and bacterial cultures.
	10-11	Microbial sensitivity testing.
	12-14	Bio-activity testing.
	15-16	Disinfection methods.