

M.TECH – COASTAL MANAGEMENT

OBJECTIVES

This interdisciplinary approach builds capacity of students to become effective coastal managers. This involves integration of 1) Engineering Technology, 2) Nature Sciences and 3) Social Sciences. Current coastal problems require trans-disciplinary knowledge as they are cross-cutting in nature.

1. Prepare students to address current and future engineering, environmental and socio-economic problems in coastal management by using a multi-disciplinary approach.
2. To develop knowledge in the management of complex/ dynamic coastal environment with interplay between physical-chemical, biological and social parameters.
3. Enhance research and development in coastal engineering and environmental issues related to oceans and coasts for the sustainable utilization of coastal resources through effective management.
4. To build capacity as efficient Coastal Managers, Policy Makers and Experts in Integrated Coastal Management (ICM).

OUTCOME

At the end of the course, students must be in a position to

1. Ability to apply knowledge from engineering, environmental and social science discipline to issues in coastal management
2. Function in a multidisciplinary team
3. Identify, formulate and solve the problems related to coastal management
4. Design, conduct, organize, and interpret data analysis related to coastal zone management issues
5. Develop hardware / software components and skills relevant to ecological, environmental, engineering and social aspects of coastal management

UNIVERSITY DEPARTMENTS
ANNA UNIVERSITY : : CHENNAI 600 025
REGULATIONS - 2013

M.TECH. COASTAL MANAGEMENT

CURRICULUM AND SYLLABUS I TO IV SEMESTERS (FULL TIME)

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8101	Coastal Marine Resources and Management	3	0	0	3
2.	CM8102	Oceanography	3	0	0	3
3.	CM8103	Sea Surveying and Monitoring	3	0	2	4
4.	CM8151	Wave Hydrodynamics	3	0	0	3
5.	MA8161	Statistical Methods for Engineers	3	1	0	4
6.		Elective I	3	0	0	3
TOTAL			18	1	2	20

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8201	Coastal Hazards and Management	3	0	0	3
2.	CM8202	Integrated Coastal Management	3	0	2	4
3.	CM8203	Satellite Oceanography	3	0	2	4
4.	CM8251	Coastal Engineering	3	0	0	3
5.		Elective II	3	0	0	3
6.		Elective III	3	0	0	3
TOTAL			18	0	2	20

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8301	Coastal Environmental Impact Assessment	3	0	0	3
2.	CM8302	Marine Ecology and Toxicology	3	0	2	4
3.		Elective IV	3	0	0	3
4.	CM8311	Project Work Phase I	0	0	12	6
TOTAL			9	0	14	16

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8411	Project Work Phase II	0	0	24	12
TOTAL			0	0	24	12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF M.TECH DEGREE = 68

ELECTIVES FOR M.TECH. COASTAL MANAGEMENT

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8001	Coastal Aquaculture and Engineering	3	0	0	3
2.	CM8002	Coastal Biodiversity	3	0	0	3
3.	CM8003	Coastal Resource Economics	3	0	0	3
4.	CM8004	Corrosion Engineering	3	0	0	3
5.	CM8005	Environmental Geochemistry	3	0	0	3
6.	CM8006	Environmental Hydrogeology	3	0	0	3
7.	CM8007	Field and Research Methodology	3	0	0	3
8.	CM8008	GIS and Customization	2	0	2	3
9.	CM8009	Global Climate Change	3	0	0	3
10.	CM8010	Numerical Modeling for Coastal Processes	2	0	2	3
11.	CM8011	Radar Remote Sensing	3	0	0	3
12.	CM8012	Socio-economic aspects in Coastal Management	3	0	0	3
13.	CM8013	Space Geodesy	2	0	2	3
14.	CM8014	Water Quality and Pollution	3	0	0	3



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M.TECH. COASTAL MANAGEMENT

CURRICULUM AND SYLLABUS I TO VI SEMESTERS (PART TIME)

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8102	Oceanography	3	0	0	3
2.	MA8161	Statistical Methods for Engineers	3	1	0	4
3.		Elective I	3	0	0	3
TOTAL			9	1	0	10

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8202	Integrated Coastal Management	3	0	2	4
2.	CM8101	Coastal Marine Resources and Management	3	0	0	3
3.		Elective II	3	0	0	3
TOTAL			9	0	2	10

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8302	Marine Ecology and Toxicology	3	0	2	4
2.	CM8151	Wave Hydrodynamics	3	0	0	3
3.		Elective III	3	0	0	3
TOTAL			9	0	2	10

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8203	Satellite Oceanography	3	0	2	4
2.	CM8201	Coastal Hazards and Management	3	0	0	3
3.		Elective IV	3	0	0	3
TOTAL			9	0	2	10

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8251	Coastal Engineering	3	0	0	3
2.	CM8301	Coastal Environmental Impact Assessment	3	0	0	3
3.	CM8103	Sea Surveying and Monitoring	3	0	2	4
4.	CM8311	Project Work Phase I	0	0	6	3
TOTAL			9	0	8	13

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8411	Project Work Phase II	0	0	30	15
TOTAL			0	0	30	15

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF M.TECH DEGREE = 68

ELECTIVES FOR M.TECH. COASTAL MANAGEMENT

SL. NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1.	CM8001	Coastal Aquaculture and Engineering	3	0	0	3
2.	CM8002	Coastal Biodiversity	3	0	0	3
3.	CM8003	Coastal Resource Economics	3	0	0	3
4.	CM8004	Corrosion Engineering	3	0	0	3
5.	CM8005	Environmental Geochemistry	3	0	0	3
6.	CM8006	Environmental Hydrogeology	3	0	0	3
7.	CM8007	Field and Research Methodology	3	0	0	3
8.	CM8008	GIS and Customization	2	0	2	3
9.	CM8009	Global Climate Change	3	0	0	3
10.	CM8010	Numerical Modeling for Coastal Processes	2	0	2	3
11.	CM8011	Radar Remote Sensing	3	0	0	3
12.	CM8012	Socio-economic aspects in Coastal Management	3	0	0	3
13.	CM8013	Space Geodesy	2	0	2	3
14.	CM8014	Water Quality and Pollution	3	0	0	3

OBJECTIVES:

- To assess the various living and non-living resources, resource exploration and exploitation and strategies for sustainable management of coastal and marine resources.
- To link marine ecology and environmental policies for effective management of coastal resources

UNIT I COASTAL AND MARINE RESOURCES 9

Types and functions of coastal and marine resources – Coastal zone as an integrated resource area – Marine resources: biotic, mineral and energy resources, Renewable vs. Non-Renewable Resources – Marine geophysical methods – Sea floor resource exploration, Marine archeology

UNIT II NON-LIVING MARINE RESOURCES 9

Marine minerals – Placer deposits – Hydrocarbon deposits – Polymetallic nodules – Extraction of natural minerals – Methyl/ Gas Hydrates – Sea Salt

UNIT III LIVING MARINE RESOURCES 9

Living Marine Resources (LMR) and livelihoods, Managing LMR – Marine Protected Areas (MPA) – Large Marine Ecosystems (LMEs) – Ecosystem based approach, Climate effects on living marine resources – Biological monitoring of marine ecosystems

UNIT IV SUSTAINABLE USE OF RESOURCES 9

Renewable energy from the ocean – Hydrocarbons, Gas, Wind, Wave – Tides – Currents – OTEC, seabed mining, Beach sand mining, Anthropogenic impacts: Overfishing — Ocean dumping – Oil spills – Coral reef bleaching

UNIT V COASTAL AND MARINE RESOURCE MANAGEMENT 9

Defining resource management – legislation for resource management– Conflicting interests with other coastal and marine activities – Ecotourism – Management tools – Ecosystem health and protection of biological diversity– international conventions related to resource management (e.g. UNCLOS, CBD) Future uses of the oceans.

TOTAL: 45 PERIODS**OUTCOME:**

- Students are able to assess the various living and non-living resources, resource exploration and exploitation and strategies for sustainable management of coastal and marine resources; Design, organize and interpret data analysis; environmental policies for effective management of coastal resources and Communicate effectively in speech and writings

REFERENCES:

1. Beer, T., Environmental Oceanography: II Ed. (Marine Science Series), CRC Press, 1997.
2. Kennish, M.J., Pollution Impacts on Marine Biotic Communities, CRC Press, New York, 1998.
3. Alongi, D.M., Coastal Ecosystem Processes, CRC Press, New York, 1998.
4. Eisma, D., Intertidal deposits, River Mouths, Tidal flats and Coastal Lagoons, CRC Press, New York, 1998.
5. Newman, M.C., Roberts Jr. M.H. and Male, R.C. (Eds.), Coastal and Estuarine Risk Assessment, Lewis Publishers, Washington D.C. 2002.

OBJECTIVES:

- To provide an overview of the fundamental principles of ocean science and technology.
- To promote cross-disciplinary, multiscale research and education in marine sciences.
- To provide the background needed to undertake oceanographic investigations and sets them in context by incorporating case studies and sample problems based on local and global examples.

UNIT I PHYSICAL OCEANOGRAPHY 9

Ocean sciences and the scope of physical oceanography- Origin of Ocean and Ocean basin- Introduction to bottom topography- Properties of Seawater – Ocean dynamics and upwelling– Heat Budget – Ocean currents and circulation – Coastal landforms – waves, tides, sea level- Oceanographic Methods and Instruments

UNIT II CHEMICAL OCEANOGRAPHY 9

Introduction to Chemical Oceanography – Chemical composition of seawater – Concept of Chlorinity & Salinity of sea water- Thermodynamics – Carbonate system– Redox equilibria – Biogeochemical cycles – Air-sea interactions – Trace metal geochemistry – Organic geochemistry – Tracers in the ocean – Minerals from the Sea– Mineral Weathering

UNIT III BIOLOGICAL OCEANOGRAPHY 9

The Marine realm – Phytoplankton diversity, diurnal vertical migration – Photosynthesis and primary productivity and seasonality – Eutrophication and Harmful algal blooms (HABs) – Zooplankton and Secondary production, grazing pressure – Respiration – Nekton – Trophic Dynamics – Marine microbes and microbial Loop – Limiting nutrients in seawater

UNIT IV GEOLOGICAL OCEANOGRAPHY 9

Structure of Earth's interior – Evolution of the Ocean- Continental drift and plate tectonics- tectonic history – Stratigraphy – Geochronology — Sea level rise – Marine sediments classification – Marine microfossils – Paleooceanography and global climate- Geophysical methods and instruments

UNIT V ENVIRONMENTAL OCEANOGRAPHY 9

Definitions and development of the DPSIR framework – Drivers and Pressures – State and Impacts – Drivers – Response(s) and Discussion – Case Studies from Indian Coastline – Case Study from Cruise – Ocean Data View.

TOTAL: 45 PERIODS**OUTCOME:**

- Increase in knowledge in ocean sciences, able to identify and solve problems in ocean sciences and promotes to work in a multi disciplinary team.

REFERENCES:

1. Garrison, T., Oceanography: An Invitation to Marine Science, 5th Edition, Brooks, 2007
2. Keith A. Sverdrup, Alison B. Duxbury, Alan C. Duxbury : Fundamentals of Oceanography, 5th Edition, 2005.
3. Gross, M.G. Principles of Oceanography, 7th Edition, Prentice-Hall, 1995.
4. Carol M. Lalli and Timothy R. Parsons. Biological Oceanography: An Introduction (II Ed.), 1997 Elsevier Ltd.

OBJECTIVES:

- To introduce the students to the practical issues involved in a coastal survey based on ongoing cooperative research programs at various survey locations and associated instrumentation
- In addition to usual hydrographic surveys connected with nautical charting, Coastal surveying at larger scales with precise instrumentation is also introduced.

UNIT I BASICS OF COASTAL AND HYDROGRAPHIC SURVEYING**6**

Large scale coastal land surveying – Modern instrumentation – Hydrographic surveys for coastal regions – Fields of applications and uses – Standard specifications and zones of confidence for hydrographic surveys – Nautical charts – Nautical Information Systems

UNIT II PRINCIPLES OF POSITIONING - BASICS**9+10**

Shape of the Earth – Ellipsoid – Local Sphere – Geoid Datum – Types of Datum – Horizontal and Vertical Datum – Coordinate Systems – Principles of Cartography – Projections – Different types – Universal Transverse Mercator (UTM) projection – Electronic Distance Measurements

UNIT III PRINCIPLES OF POSITIONING - INSTRUMENTATION**9+12**

Survey of India – Triangulation stations – Positioning Methods – Horizontal Control Methods – Vertical Control Methods – Instruments used – Topographic surveying applied to hydrography- Global Positioning systems (GPS) – establishing control points – Intensification of control – Precise spirit leveling – Trigonometric leveling – Use of modern electronic surveying instruments – Total station – Coastal hydrographic surveying – LIDAR surveying for Digital Elevation Models (DEM) – Delineation of coastline and demarcation

UNIT IV DEPTH DETERMINATION AND SEAFLOOR FEATURE DETECTION**12+4**

Fundamentals of acoustic wave propagation in ocean waters – Sound velocity computation – Attenuation – Refraction and reflection – Frequency – Band width – Pulse length – Acoustic Instrument operation – Data recording and processing – Side scan – Practical use of Side scan – Plotting and measurements from Sonar records – Multi beam Echo sounders – Feature detection and Sea floor classification

UNIT V WATER LEVELS AND FLOW MEASUREMENTS**9+4**

Principles of Tides and Water Levels – Astronomical Tide Producing Forces – Tidal Characteristics – Non-tidal water level variations – Tide and water level Datum – Harmonic Analysis and Tide Prediction – Principles of Tidal Currents – Measurements and Prediction of Currents

TOTAL (L: 45 + P: 30): 75 PERIODS**OUTCOME:**

- Students become aware of the practical issues involved in a coastal survey in addition to usual hydrographic surveys connected with nautical charting and associated instrumentation; Construct hardware/ software relevant to Engineering, Environmental and social aspects and Understand professional, ethical, legal issues and associated with them.

REFERENCES:

1. Ask, T., Handbook of Marine Surveying, Sheridan House, 2007.
2. Ghilani, C.D. and Wolf, P.R., Elementary Surveying: An Introduction to Geomatics, Published by Prentice Hall, 2008.
3. Kennish, M.J., Practical Handbook of Marine Science, CRC Press, 2001.
4. Brekhovskikh, L.M. and Lysanov, Y.P., Fundamentals of Ocean Acoustics, Springer, 2003.
5. Dean, R.G. and Dalrymple, R.A., Coastal Processes with Engineering Applications. Cambridge University Press, 2002.

OBJECTIVE:

- To make the students be aware of the mass, moment and wave energy transformations, Wave kinematics and wave loads that are happening in nature and enable them in the prediction and analysis of sediment distribution along coastal areas, shore protection and hazard management.

UNIT I CONSERVATION OF MASS, MOMENT AND ENERGY 9

Conservation of mass, moment and Energy; Euler Equation – Bernoullis Equation. Potential and Stream function.

UNIT II CLASSIFICATION OF OCEAN WAVES 9

Linear wave theory : Governing Equation, Boundary Conditions and solutions, Dispersion relation, Constancy of wave period.

UNIT III WAVE KINEMATICS 9

Wave celerity, water particle velocities, accelerations, displacements and pressures. Approximations for deep and shallow water conditions. Integral properties of waves: Mass flux, Energy and energy flux, Group speed, Momentum and momentum flux.

UNIT IV WAVE TRANSFORMATIONS 9

Shoaling, bottom friction and damping, refraction, reflection and diffraction. Wave Breaking: Type of breaking, Surf similarity parameter. Keulegan-Carpenter number, Ursell Parameter, Scattering parameter, Reynolds Number.

UNIT V WAVE LOADS 9

Non breaking wave forces on slender structures – Morison equation; Diffraction theory, source distribution method. Introduction to non-linear wave theories-Stokes, Cnoidal and Solitary wave theory. Mass transport velocity, Introduction to Random and directional waves.

TOTAL: 45 PERIODS**OUTCOME:**

- Students become aware of wave energy transformations, wave kinematics and enable them in the prediction / analysis of sediment distribution along coastal areas, shore protection and hazard management.

REFERENCES

- Sarpkaya, T. and Isaacson, M., Mechanics of Wave Forces on Offshore Structures, Van Nostrand Reinhold Co., New York, 1981
- Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994
- Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, inc., New York, 1978
- Shore Protection Manual Volume I and II, Coastal Engineering Research Centre, Dept, of the Army, US Army Corps of Engineers, Washington DC, 1984
- Sorenson, R.M., Basic Coastal Engineering, A Wiley-Interscience Publication, New York, 1978.
- Goda, Y. 2000. Random seas and Design of Maritime Structures. 2nd ed. Advance Series on Ocean Engineering. Vol.15. World Scientific Publishers Pvt.Ltd. 443pp.
- Young, I.R. 1999. Wind generated Ocean Waves. Ocean Engineering Book Series. Vol.2. Elsevier. The Netherlands. 288pp.
- Narasimhan, S., S.Kathirolu, S. and B.Nagendra Kumar (Eds). 2002. Harbour and Coastal Engineering (Indian Scenario) Vol.I. NIOT, Chennai. 729pp.
- Reeves, D, Chadwick, A and Fleming, C. 2004. Coastal Engineering. Processes Theory and Design Practice. SPON Press, London. 461pp.

OBJECTIVE:

- To study and understand the concepts of Statistical methods and its applications in Engineering. To study the effect of estimation theory, testing of hypothesis, correlation and regression, randomized design, and multivariate analysis.

UNIT I ESTIMATION THEORY**9+3**

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS**9+3**

Tests based on Normal, t, X^2 and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION**9+3**

Multiple and Partial Correlation – Method of Least Squares – Plane of Regression – Properties of Residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and Partial correlations in terms of lower order coefficient.

UNIT IV DESIGN OF EXPERIMENTS**9+3**

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT V MULTIVARIATE ANALYSIS**9+3**

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

L: 45 + T : 15 TOTAL : 60 PERIODS**OUTCOME:**

- On completion of this course the students will be able to solve various problems in the field of engineering employing probability and statistical methods.

REFERENCES:

- Gupta.S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, Eleventh Edition, 2002
- J.E. Freund, “Mathematical Statistical”, 5th Edition, Prentice Hall of India, 2001.
- Jay L.Devore, “Probability and statistics for Engineering and the Sciences”, 5th Edition, Thomson and Duxbury, Singapore, 2002
- Murray.R. Spiegel and Larry J. Stephens, “Schaum’s Outline- Statistics”, Third Edition, Tata McGraw-Hill, 2000
- R.A.Johnson and C.B.Gupta, “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, 7th Edition, 2007
- Richard A.Johnson and Dean W.Wichern, “Applied Multivariate Statistical Analysis”, Pearson Education, Asia, 6th Edition, 2007

OBJECTIVES:

- To provide students understanding of the materials and processes associated with the major natural hazards: floods, earthquakes, tsunamis, landslides and other coastal hazards
- To be able to manage these hazards based on case studies and respond in the event of a disaster by appropriate strategies.

- UNIT I INTRODUCTION** **5**
 What is a Coastal Hazard? – Natural vs. Man-made hazard - Hazard and disaster, vulnerability, resilience – coping mechanisms
- UNIT II COASTAL HAZARDS** **9**
 Coastal hazards- Cyclones, Earthquakes, Tsunami, Floods, Storm surges, Coastal erosion, Sea Level Rise–Technological Hazards – causes – impacts – responses – mitigation strategies - early warning systems
- UNIT III LAW AND POLICY** **9**
 Disaster management law and policy in India - Hyogo framework – changing paradigm of disaster management in India – response and recovery framework - enabling institutions– institutional coordination
- UNIT IV DISASTER MANAGEMENT** **13**
 Disaster risk response frameworks - Mapping and planning for disaster management - capacity building – risk transfer mechanisms –bioshields – community based disaster management systems – indigenous knowledge for disaster management - NDMA guidelines - Building codes, land use planning and disaster management.
- UNIT V CASE STUDIES** **9**
 Green card concept - Reduction of carbon footprints - Case studies of Earthquake (Bhuj), tsunami (2004 Indian Ocean tsunami), cyclones (supercyclone,1999 Odisha), other cyclones, coastal erosion, oil spills, chemical disasters, nuclear disasters – vulnerability of coastal megacities - lessons from building back better.

TOTAL: 45 PERIODS

OUTCOME:

- Students will understand the processes associated with the major natural hazards i.e floods, earthquakes, tsunamis, landslides etc Understand professional, ethical, legal issues and associated responsibilities; management of these disasters through appropriate strategies and Communicate effectively in speech and writings

REFERENCES

1. Bryant, E., Natural Hazards, Cambridge University Press, New York, 2006.
2. Disaster Management: Global Challenges Local Solutions. (Rajib Shaw and RR Krishnamurthy, Eds.), University Press, 2009
3. National Disaster Management Agency – Guidelines issued by NDMA such as for earthquakes, tsunamis, cyclones, chemical disasters etc. www.ndma.gov.in
4. National Disaster Management Division, Ministry of Home Affairs, GoI. <http://www.ndmindia.nic.in/> Regularly issued guidelines and training materials especially for disaster management policy, reconstruction of buildings etc
5. United Nations office for Disaster Risk Reduction www.unisdr.org various publications and guidelines that are constantly updated
6. Asia Disaster Preparedness Centre. Publications specific to disaster preparedness and response in Asia. www.adpc.net

OBJECTIVES:

- To be able to “see” the features and components of the natural, engineering and human aspects of the coast, the functions of components and relationship between them.
- To integrate the interpretation and analysis of the identified coastal issues to determine appropriate approaches to manage the humans and the coastal environment.

UNIT I THE NEED FOR ICM AND FUNDAMENTAL CONCEPTS 6+0

Introduction: The Coasts – Unique, Valuable and Threatened – The Need for ICM – Examples of Interactions among Coastal and Ocean Uses and Their Environments – Early Efforts at Coastal Management – What is ICM – Goals – Integration – Functions – Principles – Stages in Developing an ICM Program – Capacity – Institutions – ICM (2011 notification).

UNIT II ICM FRAMEWORK AND PROCESSES 9+6

Introduction – Pathway through the framework – ToR - Tools and techniques– ICM Processes – Stakeholder analysis – Environmental assessment – Problem tree analysis – Conflict resolution – Risk evaluation – Cost Benefit Analysis – Traditional management

UNIT III COASTAL LAWS, POLICIES, INSTITUTIONS AND GOVERNANCE 5+0

Law of the Sea [UNCLOS] –Coastal regulation zones including small islands – Environmental policies – Spatial planning – Administrative and legal situations – Institutions and Governance Mechanisms

UNIT IV INTEGRATING DISCIPLINARY PERSPECTIVES 5+6

Social science insights – Natural science insights – Horizontal integration – Vertical integration – Problem and objective analysis – Monitoring and evaluating management

UNIT V PRACTICE ORIENTED LEARNING 5+18

Case studies (including field work) – Resource survey – Transect walks – learning through observation – Observing in practice – Participatory observation – Focus group discussions – Group ordering – Interpreting observations

TOTAL (L: 30 + P: 30): 60 PERIODS

OUTCOME:

- Students are able to identify natural, engineering and human components on the coast; functions of components and relationship between them; able to integrate the interpretation and analysis of the identified coastal issues to determine appropriate approaches in coastal management and able to communicate effectively in speech and writings

REFERENCES:

1. Cicin-Sain, B and Knecht, R.W., Integrated Coastal and Ocean Management: Concepts and Practices. Washington, DC, Island Press, 1998.
2. Clark, J.R. Coastal Zone Management Handbook, CRC Press Environmental Studies 1995.
3. Holder, S., Bearley, T., Brower, D.J. and Schwab, A.K., An Introduction to Coastal Zone Management, 2nd edition. Island Press, Washington, DC, 2002.
4. Le Tissier, M.D.A., Ireland, M., Hills, J.M., McGregor, J.A., Ramesh, R. and Hazra, S. (eds). A Trainers' Manual for Integrated Coastal Management Capacity Development. Integrated Coastal Zone Management and
5. Training (ICZOMAT) Project. The University of Newcastle upon Tyne, Newcastle upon Tyne, U.K. 2003.
6. Le Tissier, M.D.A., S. Coulthard, D. Rath and H.A.Y. Whyte (eds), Integrated Coastal Management –From post-graduate to professional Coastal Manager – A Teaching Manual. www.coastalprofs.eu, 2008.
7. Ramesh, R. and Purvaja, R., E-learning module on ICZM for UNESCO-IHE, The Netherlands, 2006.

OBJECTIVES:

- To describe the physical principles of remote sensing including: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems will be taught.
- To provide the oceanographic applications of satellite remote sensing through field surveys and hands-on training of GIS and remote sensing tools in coastal environment

UNIT I REMOTE SENSING**10+6**

Remote Sensing principles – Resolutions – Sensors and platforms with reference to oceanographic parameters – Digital Image Processing; Radiometric, geometric and atmospheric corrections – Enhancement and classification techniques

UNIT II GEOGRAPHIC INFORMATION SYSTEM**6+12**

Elements of GIS – Data Models, structures, management and Data Quality – Database implementation – GIS software – Housekeeping tools, Basic spectral analysis – Visualisation – Organisational and technical issues – Standards

UNIT III OCEANOGRAPHIC APPLICATIONS – I**12+2**

Visible wavelength - "Ocean Color" Sensors – SST from IR scanning radiometers – Introduction to microwave radiometer - Passive microwave radiometers – Current sensors and platforms

UNIT IV OCEANOGRAPHIC APPLICATIONS – II**10+4**

Active microwave remote sensing – Sea surface topography from Radar altimetry – Scatterometer for wind parameters – SAR Imagery and applications – Current sensors and platforms

UNIT V REMOTE SENSING APPLICATION TO COASTAL ENVIRONMENT**7+6**

Mapping Coral Reefs, Macroalgae and Mangrove – Shoreline changes - Coastal landuse and Landcover mapping – Coastal geomorphology

TOTAL (L: 45 + P: 30): 75 PERIODS**OUTCOME:**

- Students will understand the physical principles of remote sensing and will have the capacity to use oceanographic applications of satellite remote sensing through field surveys and hands-on training of GIS and remote sensing tools in coastal environment

REFERENCES

1. Lillesand, T.M. and Kieffer R.W., Remote Sensing and Image Interpretation. John Wiley & Sons, U.S.A, 2000.
2. Burrough, P.A and McDonnell R.A., Principles of Geographic Information Systems. Oxford Press, U.K, 1998.
3. Green, E.P., Mumby, P.J., Edwards, A.J. and Clark, C.D., Remote Sensing Handbook for Tropical Coastal Management – Coastal Management Sourcebooks 3. (Ed.) Edwards A.J., UNESCO Publishing, France, 2000.
4. Robinson, I.S., Satellite Oceanography. John Wiley and Sons, 1985.
5. Martin, S. An Introduction to Ocean Remote Sensing. Cambridge University Press, 2004.

OBJECTIVE:

- The main purpose of coastal engineering is to protect harbors and improve navigation. The students to the diverse topics as wave mechanics, wave climate, shoreline protection methods and laboratory investigations using model studies.

UNIT I INTRODUCTION TO COASTAL ENGINEERING 9

Indian Scenario – Classification of Harbours. Introduction - wind and waves – Sea and Swell - Introduction to small amplitude wave theory – use of wave tables- Mechanics of water waves – Linear (Airy) wave theory, Introduction to Tsunami

UNIT II WAVE PROPERTIES AND ANALYSIS 9

Behaviour of waves in shallow waters, Introduction to non-linear waves and their properties – Waves in shallow waters – Wave Refraction, Diffraction and Shoaling –Hindcast wave generation models, wave shoaling; wave refraction; wave breaking; wave diffraction random and 3D waves- Short term wave analysis – wave spectra and its utilities - Long term wave analysis- Statistics analysis of grouped wave data.

UNIT III COASTAL SEDIMENT TRANSPORT 9

Dynamic beach profile; cross-shore transport; along shore transport (Littoral transport), sediment movement

UNIT IV COASTAL DEFENSE 9

Field measurement; models, groins, sea walls, offshore breakwaters, artificial nourishment - planning of coast protection works - Design of shore defense structures –Case studies.

UNIT V MODELING IN COASTAL ENGINEERING 9

Physical modeling in Coastal Engineering – Limitations and advantages – Role of physical modeling in coastal engineering – Numerical modeling – Modeling aspects – limitations – Case studies using public domain models, Tsunami mitigation measures

TOTAL: 45 PERIODS**OUTCOME:**

- Students will understand coastal engineering aspects of harbors methods to improve navigation, shoreline protection and other laboratory investigations using model studies and to use the skills and techniques in ICM.

REFERENCES:

- Mani J.S., Coastal Hydrodynamics. PHI Pvt.Ltd. New Delhi – 2012.
- Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
- Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill, Inc., New York, 1978.
- Sorenson, R.M., Basic Coastal Engineering, A Wiley-Interscience Pub. New York, 1978.
- Coastal Engineering Manual, Vol. I-VI, Coastal Engineering Research Centre, Dept. of the Army, US Army Corps of Engineers, Washington DC, 2006.
- Kamphuis, J.W., Introduction to Coastal Engineering and Management
- Sorensen, R.M., “Basic Coastal Engineering”, 3rd Edition, Springer, 2006.
- Coastal Engineering Manual (CEM). US Army Coastal Engineering Research Center, 2002-2006. (<http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=ARTICLES;104>)
- Narasimhan S., Kathioli S. and Nagendra Kumar B. “Harbour and Coastal Engineering (Indian Scenario)” Vol.I and II.NIOT Chennai 2002.

OBJECTIVES:

- To provide a description of the existing natural and socio-economic environment within the area of influence of the project
- To identify the project components which might have a significant impact on the existing natural and socio-economic environment and the potential impacts of these project components on a local and regional scale
- To prepare an Environment Impact Statement including mitigation and management measures

UNIT I INTRODUCTION 9

What is EIA, Principles of EIA, EIA Requirements; Environment related legislation in India - Legislation for EIA, Coastal regulations, prior environmental clearance

UNIT II COMPONENTS AND METHODS 9

Assessing impacts on environment and society (Air, Noise, Water, Soil, Biological and Cultural environments) - Methods for Impact Identification – Matrices, Networks and Checklists –Public participation in environmental decision making – environmental risk assessment - Decision Methods for Evaluation of Alternatives – disaster management plans

UNIT III QUALITY CONTROL AND INSTITUTIONAL ARRANGEMENTS 9

Procedures to be followed – screening -scoping - preparing Terms of Reference – carrying out an EIA – mitigation – environmental management plans – environmental monitoring systems – capacity building for quality assurance – institutional arrangements for EIA – appraisal of proposals – quality control of EIA

UNIT IV EIA- ESSENTIAL SECTORS AND ISSUES 9

Coastal industries and activities – impact assessment requirements – ports and harbours – shoreline change - sewage/industrial outfalls, coastal power plants, thermal impacts on marine ecosystem – desalination plants – mitigation and management of impacts on the coastal and marine ecosystems

UNIT V CASE STUDIES 9

Cumulative impacts assessment, Strategic Impact Assessment, Case studies of EIA of developmental projects and projects on coastal areas – Preparing an EIA in India for different sectors – MoEF guidelines

TOTAL: 45 PERIODS**OUTCOME:**

- The students will understand existing natural and socio-economic environment within the area of influence of the project; project components which might have a significant impact on the existing natural and socio-economic environment and the potential impacts of these project components on a local and regional scale and to prepare an Environment Impact Statement including mitigation and management measures; able to work in multi- disciplinary team and to use skills and techniques in ICM.

REFERENCES

1. John Glasson, Riki Therivel and Andrew Chadwick. Introduction to Environmental Impact Assessment 4th Edition. Routledge – 416 pp
2. Dwi Abad Tiwi. Improving environmental impact assessment for better integrated coastal zone management. Taylor and Francis, 2003. 234 pp
3. Integrated Environmental Impact Assessment for Coastal and Marine Areas: A Training Manual. PEMSEA, 2004
4. UNESCAP. Assessment of the environmental impact of port development. United Nations, 1992

5. MoEF, Government of India. Environmental Impact Assessment – Manuals. Available from MoEF website www.envfor.nic.in
6. Environmental impact assessment and monitoring in aquaculture. *FAO Fisheries and Aquaculture Technical Paper*. No. 527. Rome, FAO. 2009. 57p.

CM8302

MARINE ECOLOGY AND TOXICOLOGY

L T P C
3 0 2 4

OBJECTIVES:

- This course will provide an understanding on different marine habitats: salt marshes, mangroves, corals, barrier beaches, rocky coastlines and Open Ocean.
- Discussion on the basic principles of ecology and also important topics of ecological concern, such as local endangered species, and pollution will be made.
- Introduction of various methods and tools that determines the toxicity of various pollutants and the ultimate fate of pollutants in marine organisms.
- This course will give opportunity to take a close look at coastal ecosystems, and learn about the scientific sampling techniques in the field and also the sample handling and analyses techniques in the lab.
- This integrated course will give chance to students, to have an overview of major coastal / marine ecological processes. Students will also become familiar with laboratory, field and research skills required of any science major.

UNIT I LIFE ON EARTH

9

Origin of the Universe - Origin of Life on the Earth – Changes and Evolutionary history of organisms – Adaptations - Disturbance and Mass Extinctions – Speciation and Types

UNIT II GENERAL ECOLOGY

9+6

Fundamentals of Ecology – Basic Ecological principles – Energy and Nutrient Relations Thermodynamics – Population distribution, dynamics and growth – Competition, predation, mutualism – Food web, trophic transfer.

UNIT III COASTAL AND MARINE ECOSYSTEMS

9+12

Estuarine and Mangrove Ecology – Soft Sediment Ecology - Salt Marsh Ecology - Coral Reef Ecology - Rocky Intertidal - Hydrothermal Vents Ecology - Polar Ecology - Human Impacts on the Marine Environment - Biofouling

UNIT IV MARINE ECOTOXICOLOGY AND TOXICANTS

9

General introduction and principles on marine toxicology – General chemistry of different types of pesticides and toxicants like Organochlorine, organophosphate, PCBs, POPs, PAH, Dioxins, heavy metals – Effect of Toxicants on animal physiology – Global transport of POPs – Mercury and Lead cycling in the environment

UNIT V RISK ASSESSMENT

9+12

Aquatic toxicology testing methods – Chemical uptake, transformation, elimination, and accumulation – Marine and estuarine invertebrate toxicity tests - Bioassays and biomarkers – Multi-species test systems – Biodegradation – Factors influencing bioaccumulation and trophic transfer – Sub-lethal effects – Acute and chronic lethal effects – Risk assessment of contaminants on communities and ecosystems

TOTAL: 60 PERIODS

Attested

Sobhan
DIRECTOR

Centre For Academic Courses
Anna University, Chennai-600 025.

OUTCOME:

- Students will understand the different marine habitats i.e. salt marshes, mangroves, corals, barrier beaches, rocky coastlines and Open Ocean; ecological principles; various methods and tools that determines the toxicity of various pollutants and the ultimate fate of pollutants in marine organisms; sample handling and analyses techniques in the lab; Design, organize and interpret data analysis; Construct hardware/ software relevant to Engineering, Environmental and social aspects and to communicate effectively in speech and writings

REFERENCES:

1. Barnes, R.S.K. and Hughes, R.N.. Introduction to Marine Ecology, 3rd ed., Blackwell Publishing, 1999.
2. Kaiser, M.J., Attrill, M.J., Jennings, S., Thomas, D.N., Barnes, D.K.A., Brierley, A.S., Polunin, N.V.C., Raffaelli, D.G., Williams, P.J. le B. 2005. Marine Ecology: Processes, Systems, and Impacts. Oxford University Press, New York, 557 p.
3. Klaassen, Curtis D. (2008). Casarett and Doull's Toxicology - The Basic Science of Poisons (7th Edition). McGraw-Hill.
4. Wright, D.A., Welbourne, P. Environmental Toxicology, Cambridge University Press, 2002.
5. Mount, D.R. and T.R. Henry. 2008. Chapter 18. Ecological Risk Assessment. In: The Toxicology of Fishes, R.T. DiGiulio and D.E. Hinton, Eds., Taylor & Francis, Boca Raton, FL, pp. 757-775.
6. Hotchkiss, A.K. et. al. 2008 A Review: Fifteen years after "Wingspread: - Environmental Endocrine Disrupters and Human and Wildlife Health: Where We Are Today and Where We Need to Go." Toxicological Sciences 105(2): 235-259.
7. Xue, W. & Warshawsky, D. 2005. Metabolic activation of polycyclic and heterocyclic aromatic hydrocarbons and DNA damage: a review. Toxicol and Pharmacol 206, 73–93.

CM8001

COASTAL AQUACULTURE AND ENGINEERING

L T P C
3 0 0 3

OBJECTIVES:

- To introduce the various aquaculture systems and technology development including the history of aquaculture, general principles, infrastructural facilities and human resources, survey and location of suitable sites, selection of suitable culturable species, layout and design of farms, construction and management.
- To teach suitable technologies and grow-out systems for culturable marine finfish and shellfish including ornamental fishes.
- To introduce finfish/ shellfish nutrition and health management, water quality management in various coastal aquaculture systems, post harvest technology, processing, economics and marketing, coastal aquaculture engineering, aquaculture extension, coastal aquaculture guidelines
- Case studies and entrepreneurship including the prospects of coastal aquaculture will be covered

UNIT I COASTAL AQUACULTURE

9

History of aquaculture – Global coastal aquaculture development and management – General Principles - Infrastructural facilities and Human resources – Water resources for aquaculture and management - Survey and location of suitable sites – Site selection for aquaculture using remote sensing - Selection of culturable species – Exotic species for aquaculture.

UNIT II LAYOUT/DESIGN AND CONSTRUCTION OF AQUACULTURE FARMS

9

Aquaculture systems - Hydrology and Morphology of soils – Design of water supply and pond - Intensive and recycling systems - Farm construction – Pond culture techniques – Cage and Pen culture systems – Hatchery construction and operation – Grow out systems - Leading canal, pumping systems, Main inlet, Electrical distribution system, Farm stead, Approach road, Peripheral dyke, Diffuser tank, Feeder Canal Dyke, inlets for culture ponds - Aeration – Biological filtration – Sterilisation and disinfection.

Attested

Sobhan
DIRECTOR

UNIT III AQUACULTURE TECHNOLOGIES 9

Fin fish and shellfish seed production technology – Fry rearing technology – Grow-out technology - Nutrition and health care – Ornamental fish culture technology - Integrated farming systems – Harvesting methods - Post harvest technology and processing – Economics and Marketing.

UNIT IV ENVIRONMENTAL ISSUES IN AQUACULTURE 9

Water quality and aquaculture production – pH, Alkalinity, Hardness, Salinity – Temperature, Dissolved Oxygen, Turbidity, Suspended solid particles, Dissolved gases, Nutrients, Hydrogen sulphide, Heavy metals and pesticides – Soil Organic Carbon- Acid sulphate soil – Phytoplankton, Zooplankton – Biological treatment of coastal aquaculture discharge of waste waters - Influence / impact of water quality on aquaculture and management – Impact of land based activities on coastal aquaculture – climate change impacts on coastal aqua culture

UNIT V ENGINEERING AND POLICIES FOR AQUACULTURE 9

Role of Engineers in Aquaculture – Aquaculture policy – Coastal Aquaculture Authority guidelines – Case studies (Finfish, Shellfish, Seaweed culture) - Sources of finance and Insurance coverage – Aquaculture extension and entrepreneurship – Building sustainable governance for coastal aquaculture - Prospects of coastal aquaculture

TOTAL: 45 PERIODS

OUTCOME:

- The students will understand various aquaculture systems and technology development for culturable marine finfish and shellfish including ornamental fishes, survey and location of suitable sites, selection of suitable culturable species, layout and design of farms, construction and management; health management, water quality management in various coastal aquaculture systems, post harvest technology; coastal aquaculture engineering, aquaculture extension, coastal aquaculture guidelines.

REFERENCES:

1. Egna, H.S. and Boyd,C.E. Dynamics of Pond Aquaculture. CRC Press. New York, USA, 1997.
2. Lucas, J.S. and Southgate P.C. Aquaculture – Farming aquatic animals and plants. Fishing News Books, Blackwell Publishing Ltd. Oxford, UK, 2003.
3. Lawson, T.B. Fundamentals of Aquacultural Engineering. CBS Publishers & Distributors. New Delhi, 1997.
4. Stickney, R.R. and McVey, J.P. Responsible marine aquaculture. CAB Publishing, New York, USA, 2002.
5. Thomas, P.C. Current and Emerging Trends in Aquaculture. Daya Publishing House, New Delhi, 1998.



CM8002

COASTAL BIODIVERSITY

**L T P C
3 0 0 3**

OBJECTIVES:

- The course focuses primarily on coastal biodiversity while maintaining an integrated approach towards management of coastal ecosystems
- Particular emphasis will be given to teaching the methodology for assessing, monitoring and conserving biodiversity in mangrove ecosystems
- This course is designed to introduce the student in an integrated manner to the field of sustainable development policy and biodiversity conservation and how it applies to the field of biodiversity and conservation as well as related areas

UNIT I	COASTAL AND MARINE BIODIVERSITY	9
Importance of coastal and marine biodiversity – classification of marine ecosystems – mangroves – tidal flats – seagrass beds – coral reefs – open ocean – ecosystem services provided by oceans and coasts -		
UNIT II	FACTORS AFFECTING COASTAL AND MARINE BIODIVERSITY	9
Ecological conditions affecting coastal and marine ecosystems –natural hazards and ecosystem resilience - human impacts on marine ecosystems – physical alteration and destruction of habitat–habitat fragmentation - harmful algal blooms – coral bleaching – invasive species – marine debris – oil spills		
UNIT III	ECOLOGICALLY SENSITIVE AREAS	9
Identifying mapping ecologically sensitive areas using remote sensing and other tools- Assessing, monitoring and conserving biodiversity in mangrove ecosystems – role of coastal ecosystems in buffering natural hazards such as cyclones, tsunamis and coastal erosion		
UNIT IV	RESOURCE MANAGEMENT PLANNING	9
Ecosystem approach to management - Marine protected areas – community based management – indigenous and traditional knowledge in conservation practices - Locally Managed Marine Areas - closed seasons – closed areas – eco tourism		
UNIT V	INTERNATIONAL AND NATIONAL POLICIES AND LEGISLATION	9
Indian legislation for environmental protection – coastal protection – wetland rules – environmental policy – Rio conventions – CBD – Jakarta Mandate – Ramsar convention – fisheries conventions		
		TOTAL: 45 PERIODS

OUTCOME:

- The students become aware of coastal biodiversity , the methodology for assessing, monitoring and conserving biodiversity, integrated approach towards management of coastal ecosystems


REFERENCES:

1. Global Threats to Coral Reefs – Chapter 1: Coral Bleaching, Global Climate Change, Disease, Predator Plagues, and Invasive Species.(PDF): Status of Coral Reefs of the World: – Vol. 1, 2004.
2. Moore, H.B. Marine Ecology. Wiley Interscience, 1958.
3. Raffaelli, D.G. and Hawkins, S.J. Intertidal Ecology. 2nd Edition, Springer, 1996.
4. Doody, J.P. Coastal Conservation and Management: An Ecological Perspective. Springer, 2000
5. Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF
6. (2012). *Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions*, Montreal, Technical Series No. 67, 61 pages.
7. Ecosystem Approach Sourcebook. CBD. <http://www.cbd.int/ecosystem/sourcebook/>
8. Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guide. UNEP.
9. Peter J. S. Jones, WanfeiQiu, Elizabeth De Santo. Governing Marine Protected Areas – Getting the balance right. Technical Report. UNEP, 2011

CM8003	COASTAL RESOURCE ECONOMICS	L T P C
		3 0 0 3

OBJECTIVES:

- The course introduces the basic, critical appreciation of economics as applied to natural and coastal resources management
- Specific goals include comprehension of the economics of sustainability, non-market valuation, economic policy instruments and international trade and the environment

Attested

SABINA
 DIRECTOR
 Centre For Academic Courses
 Anna University, Chennai-600 025.

UNIT I OVERVIEW OF COASTAL RESOURCE ECONOMICS 9
Introduction to environmental economics – economic growth, population growth and the environment – sustainable development – ecosystem services

UNIT II ECONOMICS OF COASTAL RESOURCE EXPLOITATION 9
Natural Resources (Renewable and non-renewable) – Theory of optimal resource extraction – resource scarcity – the economics of pollution - valuing ecosystems – environmental accounting – integrating environmental and economic accounting

UNIT II ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL PROTECTION 9
Regulatory versus Economic Instruments — Polluter pays Principle - Pigovian and Pollution Taxes - Indian legislation for environmental protection - Charges and Subsidies –Tradable permits— Evaluation of Instruments – Choice of instruments for Environmental policy – international and global environmental pollution problems

UNIT IV BENEFIT-COST ANALYSIS / VALUATION TECHNIQUES OF COASTAL RESOURCES 9
Principles of cost benefit analysis –Opportunity costs – Market and non-market valuation techniques – Abatement Cost methods – Behaviour Linkage Methods – Economic value v/s. Environmental Value and Issues of non-human value – Costs of Sustainability – methods for valuation

UNIT V ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY 9
TEEB approach to recognizing, demonstrating and capturing values of ecosystems – practical applications – accounting for risk and uncertainty – natural capital and poverty reduction – mainstreaming economics of nature – ecological infrastructure and climate change

TOTAL: 45 PERIODS

OUTCOME:

- The students will understand basic, critical appreciation of economics as applied to natural and coastal resources management; economics of sustainability, non-market valuation, economic policy instruments and international trade.

R EFERENCES

1. Perman, R., Ma, Y. and McGilvray, J. Natural Resources and Environmental Economics, II Edition, Addison Wesley Longman Ltd., Singapore, 1997.
2. Bowers, J. Sustainability and Environmental Economics, Addison Wesley Longman Ltd., Singapore, 1997.
3. Environmental Economics – An Indian Perspective (Ed: Rabindra N. Bhattacharya). Oxford India. 2001
4. Gadgil, M and R. Guha. This Fissured Land: An Ecological History of India. Oxford India. 1992
5. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations (Ed Pushpam Kumar). Earthscan, 2012.

CM8004 CORROSION ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- The course will be an overview of the various aspects of corrosion and the result of interaction between metals by chemical or electrochemical reaction with the environments
- Studies on gradual destruction and decay of materials by chemical or biological agents are included
- The potency and consequences of corrosion which destroys economy, depletes resources, plants, equipments and other components are highlighted
- The explanation of different forms of corrosion, rates of corrosion and mechanisms of corrosion are provided in corrosion engineering

Attested

Sobhan
DIRECTOR

UNIT I	CORROSION	9
General, electrochemical corrosion of metals, galvanic cells, corrosion rates (kinetics), types of corrosion with properties and phenomenon, oxidation metals.		
UNIT II	CORROSION TESTING	9
Importance, classification materials and specimens, surface preparation, measuring and weighing, exposure techniques, duration, planned interval tests.		
UNIT III	CORROSION PREVENTION	9
Material selection, modification of metal, alternate of environment, design, cathodic and anodic protection, coatings (metallic, inorganic, non metallic and organic)		
UNIT IV	CORROSION IN SELECTED ENVIRONMENTS	9
Atmospheric Corrosion, Corrosion in Automobiles, Corrosion in Soils, Corrosion of Steel in Concrete, Corrosion in Water, Microbiologically Induced Corrosion, Corrosion in the Body		
UNIT V	CORROSION IN INDUSTRIES	9
Corrosion in the Petroleum Industry, Corrosion in the Aircraft Industry, Corrosion in the Microelectronics Industry		

TOTAL: 45 PERIODS

OUTCOME:

- The students will understand various aspects of corrosion; interaction between metals with chemicals or electrochemicals reaction and with the environments; potency and consequences of corrosion.

REFERENCES:

1. Jones, D.A. Principles and Prevention of Corrosion, 2nd Edition, Macmillan Publishing Co., 1995.
2. Balasubramanian, M.R., Krishnamoorthy, S. and Murugesan, V., Engineering Chemistry, Allied Publisher Limited., Chennai, 1993.
3. Sadasivam, V. Modern Engineering Chemistry - A Simplified Approach, Kamakya Publications, Chennai, 1999.
4. Kuriakose, J.C. and Rajaram J. Chemistry in Engineering and Technology, Vol. I and II, Tata McGraw-Hill Publications Co. Ltd., New Delhi, 1996.

CM8005	ENVIRONMENTAL GEOCHEMISTRY	L T P C
		3 0 0 3

UNIT I	PRINCIPLES OF ENVIRONMENTAL GEOCHEMISTRY	9
The science of Geochemistry – Its objectives, its relationship to other geosciences and its methodology. The natural workings of the Earth: Natural distributions of chemicals in global and local environments. Geochemistry of the Earth: The birth of matter in our solar nebula, formation of the solar system and early geochemical history of the earth. The geochemical cycle – Distribution of elements in rocks		
UNIT II	THE CONTINENTAL ENVIRONMENT	9
Hydrologic cycle – Dissolution and precipitation of silica, aluminum and iron hydroxides - Geochemistry of surface and ground waters – Rivers, ground water and lakes. Complex formation and chelation. Metals and nonmetals. Radioactive isotopes and radioactive waste.		
UNIT III	MARINE ENVIRONMENT	9
Physical and chemical properties of open ocean seawater chemistry. Trace metals in sea waters. Types of metal distributions. Geochemistry of marine sediments. Marginal marine environments. Perturbations caused by humans: chemical distributions in anthropogenically "perturbed" systems.		

Attested

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UNIT IV ENVIRONMENTAL MINERALOGY 9
 Basic mineralogy – Definition of a mineral – Types of minerals – Crystal chemistry – X – ray Crystallography. Basic silicate structures – zeolites – asbestos minerals – health effects of asbestos exposure. Mineral-microorganism interactions.

UNIT V GEOCHEMICAL EXPLORATION ENVIRONMENT 9
 Introduction – Primary Dispersion pattern Secondary dispersion pattern. Background values – Geochemical anomaly – Geochemical sampling - Weathering – Soils.

TOTAL: 45 PERIODS

REFERENCES

1. Arthur Brownlow, Geochemistry (Second edition), Pearson Education, INC., 1996.
2. Faure, G., Principles and applications of Geochemistry, Pearson Education, INC., 1998.
3. Nelson EBY,G., Principles of Environmental Geochemistry, Thomson Brooks/Cole, 2004.
4. Fraure, G, Principles of isotope geology, John Wiley, II edition. 1986.

CM8006 ENVIRONMENTAL HYDROGEOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION 9
 Hydrological cycle - geological formations as aquifers - aquifer parameters - their estimation - groundwater flow and recharge - environmental impacts related to hydrogeology

UNIT II HYDROGEOLOGICAL IMPACTS 9
 Mass movements - land subsidence - causes - hydrocompaction – sink holes – natural compaction - groundwater problems in mines and slopes

UNIT III GEOLOGICAL ASPECTS OF WASTE DISPOSAL SITES 9
 Physiography - nature of rock types - structure - hydrogeological considerations - data required - formation fluid tests - transport mechanisms of polluted groundwater

UNIT IV GROUNDWATER CONTAMINATION 9
 Water quality standards – transport processes – sources of contamination – oil spills – deep well disposal site locations – sea water intrusion - hydrogeological systems and monitoring

UNIT V GROUNDWATER PROTECTION 9
 Groundwater contamination - methods of assessment - application of groundwater modelling - damage prevention - remediation of aquifers – bio remediation of contaminated aquifers

TOTAL: 45 PERIODS

REFERENCES

1. Soliman, M.M et al . Environmental Hydrogeology, Lewis Publ., 1997
2. Freeze, R.A and Cherry, J.A Groundwater, Prentice Hall, 1979
3. Coates,D.R. Environmental Geology, John Wiley, 1981
4. Keller, E.A, Environmental Geology, Columbus, 1985
5. Marcel van der Perk, Soil and Water Contamination: From Molecular to Catchment Scale, Taylor Francis, 2006
6. Appelo, C.A.J. and D. Postma, Geochemistry, Groundwater and Pollution, Taylor & Francis; II edition, 2005.

CM8007

FIELD RESEARCH METHODOLOGY

L T P C
3 0 0 3

OBJECTIVE:

- To teach interdisciplinary field research skills to enable students design field experiments, collect and analyse data and make inferences.

UNIT I INTERDISCIPLINARY RESEARCH 8

Types of research – Inter disciplinary and multi disciplinary in research; Tools and techniques: Socio-economics, Hydrological, Physico-chemical and Agro-ecological investigations – Research design – Hypotheses- Types of data

UNIT II QUALITATIVE METHODS 7

PRA and RRA tools – Field observation and evaluation – Stakeholder perceptions – Stakeholder analysis – Stakeholder diagramming – Integrated research concept development; SPQR – Research questions – Research ethics – Research execution in the field.

UNIT III SEMI QUANTITATIVE METHODS 7

Sources of secondary data – Primary field surveys – Design and construction of questionnaire – Administration of questionnaire – Collection of data

UNIT IV STATISTICAL METHODS 8

Data editing and data transformations – Grouping variables – descriptive and graphical analysis – Correlation and Regression – ANOVA – Non-Parametric tests – Multi-variate analysis – SYSTAT package

UNIT V FIELD WORK 30

Conduct a case study – PRA and RRA tools – Training in concept and methods of field research

TOTAL (L: 30 + P: 30): 60 PERIODS

OUTCOME:

- The students will enhance their skills in interdisciplinary research areas; to enable them to design field experiments, collect and analyse data and to make inferences.

REFERENCES

1. Wilkinson and Bhandarkar, Methodology and Techniques of Social Research, 17 Ed. Himalaya Publishing House, 2004.
2. Creswell, J.W, Research Design, Sage Publications India, New Delhi, 2008
3. Kvale, S and S.Brinkmann, Interviews: Learning the craft of qualitative research, Sage Publications India, New Delhi, 2008
4. Anderson, L, F.Borum, P.H.Kristensen and P.Karnoe. On the art of doing field studies: An experience based research methodology, Copenhagen Business School Press, Denmark, 1995
5. Norman, D.W, F.DSiebert and E.Modiakgotta, The farming system approach to development and appropriate technology generation, FAO, Rome, 1995.

CM8008

GIS AND CUSTOMIZATION

L T P C
2 0 2 3

OBJECTIVES:

- In this course, the students are introduced to Visual Basic (VB) programming through practice VB programs using Map Objects. In addition, students learn how to use the latest version of MapObjects ActiveX control developed by ESRI.
- Spatial selection, thematic mapping, overlays, map projections, and web-based GIS were explored thoroughly using a blend of software design discussions addressed and explored thoroughly using a blend of thought-provoking software design discussions, detailed examples, and carefully crafted exercises.

- This essential resource offers students the programming skills to create state-of-the-art GIS applications using Map Objects and Visual Basic.
- Developing GIS Solutions with Map Objects and Visual Basic teaches GIS programming in a complete hands-on environment to Visual Basic (VB) programming through practice utilizing Map Objects are the key aspects of this course

UNIT I INTRODUCTION TO SPATIAL DATA AND MAP MODELS 5+4
 Spatial data elements & characteristics - Spatial patterns - Map scale - Map characteristics - Map projections – Map Layout - Map symbols

UNIT II GIS DATA INPUT STORAGE AND EDITING 5+4
 Input devices - Map preparation & digitization process - Methods of vector and raster input - Data storage – Editing - Topology – Attribute Table.

UNIT III GIS ANALYSIS 6+7
 Analysis of spatial information –Query – Clip – Buffer – Overlay – Interpolation – Reclassification – Area calculation

UNIT IV VISUAL BASIC PROGRAMMING 7+7
 Visual basic applications - Creating and working with controls, object & instances – Debugging - Responding to mouse events, file system, controls, processing files - Programming basics.

UNIT V MAP OBJECTS & CUSTOMIZATION 7+8
 Map objects activex control - Managing map layers, toolbars, layer management, Integration with GIS – Working with Timer – Query of Map layers – Customization of map layers with VB.

TOTAL (L: 30 + P: 30): 60 PERIODS

OUTCOME:

- The students will acquire the skill of Visual Basic (VB) programming that includes spatial selection, thematic mapping, overlays, map projections, and web-based GIS.

REFERENCES

1. Demers, M.A. Fundamentals of Geographic Information System, 2nd edition John Wiley & Sons, 1999.
2. Hutchinson, S. and Daniel, L. Inside Arc view GIS, Onward Press, 2000.
3. Schneider, D.I. Introduction to programming using Visual Basic, 6th edition, Prentice Hall Publications, 2005.
4. Stevensen, O. Visual basic 6 the complete reference, McGraw Hill, 2006.
5. Hardsen, T. Geographic Information Systems, 2nd edition, John Wiley & Sons, 1999.
6. Ralson, B.A. Developing GIS solutions with map objects & Visual Basic, Onward Press, 2002.

CM8009 GLOBAL CLIMATE CHANGE L T P C
3 0 0 3

OBJECTIVES:

- To give students the various perspectives on climatic change and the actions societies have taken to address its potential and actual impacts
- To highlight that natural processes and human activities alter the composition of the ocean and atmosphere, both globally and regionally, that trigger climate change at different temporal and spatial scales

- To provide a basic conceptual understanding of the complexity of the climate system; and the observed and potential effects of anthropogenic-induced climate change on human and natural systems based on IPCC recommendations
- To enable understanding of the international and national responses to climate change and consider individual responsibility and future challenges

UNIT I INTRODUCTION 7

Historical Overview of Climate Change Science- Changes in Atmospheric Constituents and Radiative Forcing - The Ice Ages: An Introduction – Determining Past Climates – Reconstructing Past Climate Change — Interannual to decadal variability- Observations: Atmospheric Surface and Climate Change

UNIT II OCEAN-ATMOSPHERE INTERACTIONS 10

Role of the oceans in climate -Introduction to ocean-atmosphere interactions – Global radiation balance –Ocean currents – Thermohaline circulation and deep water masses – Ocean heat budgets and water mass mixing – the cryosphere -

UNIT III IMPACTS OF CLIMATE CHANGE 10

Global warming – greenhouse effect – green house gases – impacts on physical systems – impacts on ecological systems – vulnerability of coast - climate change and biodiversity – sectoral impacts - ocean acidification – carbon sequestration by ecological systems

UNIT IV ASSESSMENT OF CLIMATE CHANGE 9

The IPCC Assessments –UNFCCC - global convention on climate change – protocols – international negotiations – Indian assessments – India’s plan of action for climate change

UNIT V ADAPTATION AND MITIGATION 9

Mitigating climate change – blue carbon– geoengineering – renewable energy and other alternate systems – adaptation indigenous knowledge – sectoral adaptations – coastal ecosystems – coastal communities – mainstreaming climate change into development practices

TOTAL: 45 PERIODS

OUTCOME:

- Students understand the various perspectives of climatic change and the actions societies have taken to address its potential and actual impacts; the natural processes and human activities alter the composition of the ocean and atmosphere at different temporal and spatial scales international and national responses to climate change; individual responsibilities and future challenges in climate change

REFERENCES

1. Wells, N., The Atmosphere and Ocean, a Physical introduction. Wiley, Chichester,1997.
2. Houghton, J., Global Warming: The Complete Briefing. 3rd Edition. Cambridge University Press, 2004.
3. IPCC Fourth Assessment Report, Climate Change, Working Group I, II, III and IV, Cambridge University Press, 2007.
4. MoEF, GoI. Indian Network for Climate Change Assessment
5. Climate Change and India: A 4X4 Assessment - A sectoral and regional analysis for 2030s. New Delhi, 2010.

OBJECTIVES:

- To introduce the usefulness and versatility of numerical, ecological, and water quality modeling in the context of environmental problem solving
- The course will have a theoretical and a practical component which will be closely interconnected.
- On the theoretical component, the basic modeling concepts will be presented as well as the implications related to the implementation and application of numerical models.
- In terms of the practical component, the objective is to develop the skills on using numerical models to study physical and biogeochemical processes in coastal systems.

UNIT I INTRODUCTION**4**

Role of mathematical models - Modeling of coastal processes - Water Quality Modeling - Introduction to Ecology & Ecological Models- Model development and validation - Basic numerical tools used in mathematical models

UNIT II MODELING OF COASTAL PROCESSES**7+7**

Equations governing processes in coastal environment: Inviscid & viscous flows, waves, coastal flow fields & estuarine flows, beach processes - Case studies of numerical solutions of equations governing coastal processes: Systems of linear algebraic equations; over-, even- and under-determined system of linear equations – Review of matrix algebra – Numerical solutions of matrix equations - Matrix Eigen value problem.

UNIT III EQUATIONS INVOLVED IN MODELING**7+7**

Interpolation & Curve-fitting - Quadratic splines & Cubic splines – System of ordinary differential equations: Initial value - Boundary-value, Eigen value Problems - Numerical Solution to Systems of Equations

UNIT IV WATER QUALITY MODELS**6+7**

Mass Balance for a well mixed system - Steady State & Time dependent solution to a well mixed system - Modeling Feed-forward & Feedback systems

UNIT V WATER QUALITY MODELING AND FEEDBACK**6+9**

Incompletely Mixed Systems – Advection and Diffusion – estuarine transport – dispersion coefficient – water quality response to inputs

TOTAL (L: 30 + P: 30): 60 PERIODS**OUTCOME:**

- The students will understand the usefulness and versatility of numerical, ecological, and water quality modeling in the context of environmental problem solving and will develop the skills on using numerical models to study physical and biogeochemical processes in coastal systems.

REFERENCES

1. Chapra, S.C. and Canale, R.P. Numerical Methods for Engineers, Tata McGraw Hill Publishing Co. Ltd., 2006.
2. Smith, G.D. Numerical solution of Partial Differential equations, Clarendon Press, 1985.
3. Chapra, S.C. Surface Water Quality Modeling, McGraw Hill Companies, Inc. 1997.
4. Reeves, D., Chadwick, A. and Fleming, C. Coastal Engineering, Spon Press, 2004.
5. Dean, R.G. and Dalrymple, R.A. Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
6. Ippen, A.T. Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc. New York, 1978.

OBJECTIVE:

- To impart the knowledge of Microwave Remote sensing and its applications.

UNIT I FUNDAMENTALS AND RADIOMETRY**6**

Introduction and early history, Basic concepts, plane waves, antenna systems, radiometry, microwave interactions with atmospheric constituents, Earth's surface and vegetation, Radiometric systems, Sensors, Data products and its applications.

UNIT II RADAR REMOTE SENSING**9**

Radar Basics, Radar interaction with Earth surface and vegetation, Surface scattering theory. Radar equation, fading concept, Measurement and discrimination, Physical mechanisms and empirical models for scattering and emission, Geometry of Radar images, Radar return and image signature, Resolution concepts, SAR, Speckle in radar imagery, concept of roughness, geometry of targets, resonance, dielectric constant, surface and volume scattering, signal penetration and enhancement.

UNIT III AIRBORNE AND SPACEBORNE RADAR SYSTEMS**9**

Airborne, Space borne, different platforms and sensors, Data products and selection procedure, SEASAT, SIRA, SIRB, ERS, JERS, RADARSAT missions, Doppler radar, JASON, TOPEX/POSEIDON, Aircraft: AirSAR, C/X SAR, E-SAR, STAR-1.

UNIT IV APPLICATION OF RADAR REMOTE SENSING**12**

Applications in Agriculture, Forestry, Geology, Hydrology, ice studies, landuse mapping and ocean related studies, military and surveillance applications, search and rescue operations, ground and air target detection and tracking.

UNIT V SPECIAL TOPICS IN RADAR REMOTE SENSING**9**

SAR interferometry- Basics- differential SAR interferometry, Radar Polarimetry- Radargrammetry and applications- Altimeter and its applications, scatterometer and its applications.

TOTAL: 45 PERIODS**OUTCOME:**

- The students will understand Microwave Remote sensing and its applications.

REFERENCES

- Ulaby, F.T., Moore, K.R. and Fung, Microwave remote sensing vol-1 and 2 Addison-Wesley Publishing Company, London, 1986.
- Floyd, M. Handerson and Anthony, J. Lewis "Principles and applications of Imaging RADAR", Manual of Remote sensing, Third edition, vol.2, ASPRS, Jhumurley and sons, Inc, 1998.
- Philippe Lacomme, Jean claud Marchais, Jean-Philippe Hardarge and Eric Normant, Air and spaceborne radar systems-An introduction, Elsevier publications 2001.
- Iain H. Woodhouse, Introduction to microwave remote sensing, 2004.
- Roger J Sullivan, Kovel, Radar foundations for Imaging and Advanced Concepts, SciTech Pub, 2004.
- Ian Faulconbridge, Radar Fundamentals, Published by Argos Press, 2002.
- Eugene A. Sharkov. Passive Microwave Remote Sensing of the Earth: Physical Foundations, Published by Springer, 2003.

OBJECTIVES:

- To make students aware of the importance of “human factor” in coastal management and to recognize that many coastal problems are actually not natural but the product of human presence, behavior and intensions.
- To facilitate students to work across disciplinary boundaries and develop an approach that will enable them to incorporate human society in their understanding of coastal area management

UNIT I ICM AND THE SOCIAL SCIENCES 9

Background to ICM – Sustainability and Sustainable ICM — Competing Claims and Visions of the Coast – ICM and Interdisciplinarity

UNIT II STAKEHOLDERS, SOCIETY AND SOCIAL CHANGE 9

Identifying and classifying Stakeholders, processes of interaction with different stakeholders — Social Change along the Indian Coast, impacts of urbanization, industrialization and calamities on coastal societies

UNIT III LIVELIHOODS AND CULTURE 9

Livelihoods along the Coast — Sustainable Livelihood Framework – Vulnerability and Resilience – Changing Livelihood Dynamics. Indigenous and traditional knowledge

UNIT IV INSTITUTIONS, PROPERTY AND LAW 9

Property Rights and Coastal Management – Competing Property Rights and Resource Claims – Statutory and Customary Law – Legal pluralism,

UNIT V POLICY AND GOVERNANCE 9

Existing Policies Governing the Coast –Governance — Institutions for coastal management, Reconciling Conflicting Agendas – Future of ICM

TOTAL: 45 PERIODS**OUTCOME:**

- Students become aware of the importance of “human factor” in coastal management; will recognize that many coastal problems are actually not natural but the product of human presence, behavior and intensions; to facilitate students to work across disciplinary boundaries and will develop an approach that will enable them to incorporate human society in their understanding of coastal area management.

REFERENCES

1. Bavinck, M., Marine Resource Management: Conflict and Regulation in the Fisheries of the Coromandal Coast, Sage Publications, 2001.
2. Le Tissier, M.D.A., S. Coulthard, D. Rath and H.A.Y. Whyte (eds). Integrated Coastal Management – From post-graduate to professional Coastal Manager – a teaching manual. www.coastalpros.eu, 2008.
3. Communities and Coastal Zone Management (Eds: Rajib Shaw and R.R. Krishnamurthy), Research Publishing, 2010.
4. Sustainable Livelihoods Framework. International Fund for Agricultural Development. www.ifad.org
5. Brown, Katrina, E.L. Tompkins and W.Neil Adger. Making Waves – Integrating Coastal Conservation and Development. EARTHSCAN. 2002.

OBJECTIVE:

- The objective of this course is to teach the fundamentals of space geodesy, the observation and processing of the GPS data for different applications.

UNIT I BASICS**6**

Definition – fundamentals of geodesy – Basic concepts – Historical perspectives – Development - Applications in space geodesy – Geoid and Ellipsoid - satellite orbital motion – Keplerian motion – Kepler's law – perturbing forces – Geodetic satellites.

UNIT II DIFFERENT TECHNIQUES**6**

Determination of Direction By Photography – SECOR – electronic observation techniques- Doppler effect – positioning concept – development of TRANSIT satellites

UNIT III GLOBAL POSITIONING SYSTEM**6**

GPS – different segments – space, control and user segment – satellite configuration – GPS signal structure – orbit determination and orbit representation, Anti spoofing and selective availability – task of control segment – GPS receiver- main receiver component- example of GPS receiver.

UNIT IV GPS DATA PROCESSING**6**

GPS observables – code and carrier phase observation – linear combination and derived observables – concept of parameter estimation – data processing – software modules – solutions of cycle slips, ambiguities, RINEX format. Concepts of rapid static methods with GPS - semi kinematic and pure kinematic methods – basic constellation of satellite geometry and accuracy measures.

UNIT V APPLICATION OF SPACE GEODESY**6**

Geodetic control surveys, cadastral surveying, photogrammetry and remote sensing, engineering applications and monitoring – GIS. GLONASS satellite configuration comparison – satellite laser ranging & applications – concept of satellite altimetry.

FIELD WORK**30**

Study of different GPS – Static, Kinematic observations – Downloading and Processing the GPS data.

TOTAL (L: 30 + P: 30): 60 PERIODS**OUTCOME:**

- The students will understand the fundamentals of space geodesy, the observation and processing of the GPS data for different applications.

REFERENCES

- Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.
- Guocheng Xu, GPS Theory, Algorithms and Applications, Springer – Verlag, Berlin, 2003.
- Seeber G. Satellite Geodesy, Walter De Gruyter, Berlin, 1998.
- Ahmed ei-Rabbany, Introduction to GPS, the global positioning system, Artech house publishers, 2002.
- Mohinder S.Grewal, Lawrence R.Weill, Angus P.Andrews, Global Positioning Systems, Inertial Navigation and integration, Wiley-Interscience, 2000.
- Bradford W.Parkinson, James J.Spilker, GPS: Theory & Applications progress in astronautics and aeronautics, American Institute of Aeronautics, 1996.
- D.Kalpan & Christopher Hegarthy, Understanding GPS: principles and application, Artech house publishers, 2005.
- B.Hofmann-Wellenhof, H.Lichenegger, J.Collins, Global Positioning System: Theory and Practice, 5th edition, Springer, NewYork, 2001.

OBJECTIVES:

- Introduces water quality concepts, its estimation and evaluation for irrigation purposes, besides relevant environmental problems and modelling of non-point pollution sources
- Students will understand the importance of water quality for irrigation and environment and the collection and use of water quality data.

UNIT I WATER QUALITY 10

Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – Trace constituents – Principles of water quality – Water quality investigation – Sampling design – samplers – automatic samplers – data collection platforms – Field kits and investigations – Water quality data storage, analysis and inference – Software packages.

UNIT II IRRIGATION WATER QUALITY 10

Water quality standards – Water quality for irrigation – Salinity and permeability – Irrigation practices for poor quality water – Waste water irrigation – Problems and prospects – Saline water irrigation – Future strategies – Water quality indices

UNIT III SOURCES OF WATER POLLUTION 10

Leaching of agrochemicals – Domestic sewage – Characteristics – Water pollutants from industries – Dissolved oxygen sag curve - Non-point source (NPS) models – Agricultural Non-point source (AGNPS) pollution model.

UNIT IV WATER POLLUTION ABATEMENT TECHNOLOGIES 7

Flow diagram and working principle of activated sludge process, tricking filter – oxidation pond – aerated lagoons – advantages and disadvantages and suitability – Packaged treatment units, advantages, disadvantages – Reverse Osmosis

UNIT V RECYCLING AND REUSE OF WASTEWATER 8

Reuse of wastewater in agriculture – Prevalence and issues from around the world – Pre-treatment technologies – Removal of nutrients from treated water – Economic and social dimensions – Constructed wetlands – Reed beds.

TOTAL : 45 PERIODS**OUTCOME:**

- The students become familiar with the water quality concepts, associated environmental problems and modelling of non-point pollution sources and to use of water quality data for research.

REFERENCES:

1. George Tchobanoglous, F.L.Burton, Metcalf & Eddy, H.David Stense, Wastewater Engineering : Treatment and Reuse, McGraw Hill, 2002.
2. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, McGraw Hill, 2006.
3. Stum, M and Morgan, A. Aquatic Chemistry, Plenum Pub. Co. USA, 1985.
4. Lloyd, J.W and Heathcote, J.A. Natural inorganic chemistry in relation to groundwater resources, Oxford University Press. Oxford, 1988.