DEPARTMENT OF CIVIL ENGINEERING

ANNA UNIVERSITY, CHENNAI

OUR VISION:

Department of Civil Engineering, Anna University, shall strive hard to develop and impart technical knowledge and professional skills required for Civil Engineering practice through excellence in teaching, research and consultancy to address sustainable infrastructure development needs at local, national and International levels.

OUR MISSION:

Department of Civil Engineering, Anna University shall contribute to technological and social development by

1. Providing a firm scientific and technological base in Civil Engineering to achieve self-reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas ofCivil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS - 2023

CHOICE BASED CREDIT SYSTEM

M.TECH.OCEAN TECHNOLOGY (FULL-TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the Programme M. Tech. Ocean Technology will

PEO1	Gain knowledge and skills in Ocean Technology which will enable them to have a Successfulcareer and Professional accomplishment in Academy, Public or Private Sector Organizations
PEO2	Become successful consultants in Ocean Technology and handle Turbulent Ocean, Climate Change, Environmental Policies, Marine Environmental Impact Assessment, Design and Constructionin Marine Environment.
PEO3	Contribute to the enhancement of knowledge in Ocean Technology by performing Quality research in institutions of international repute or in Research organizations or Academia.
PEO4	Practice the profession with Good communication, Leadership, Challenges, Ethics and Social Responsibility and formulate solutions that are technically sound, economically feasible, and socially acceptable.
PEO5	Function in multi-disciplinary teams in national and international level and adapt to evolving technologies through life-long learning and innovation.

PROGRAMME OUTCOMES (POs):

After going through the Two years of study, M.Tech Ocean Technology Graduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
PO1	Research Aptitude	An ability to independently carry out research / investigation and development work to solve practical problems
PO2	Technical documentation	An ability to write and present a substantial technical report/document
PO3	Technical competence	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4	Engineering knowledge, Critical analysis and Design	Demonstrate in-depth knowledge of Ocean Engineering with ability to evaluate and analyze the marine processes for the design of marine structures that are technically feasible and socially acceptable.
PO5	Development of Technological Solutions and innovations.	An ability to apply various advanced tools and technologies to develop efficient/innovative Soft and Hard solutions/ measures for Ocean and Coastal problems.
PO6	Environment monitoring and sustainability	An ability to apply relevant/ emerging technologies for Marine environment monitoring and apply/develop environmental strategies, policies and programmes that promote sustainable development of ocean and coastal resources.

Attested

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PEO / PO MAPPING:

PEO's	PO1	PO2	PO3	PO4	PO5	PO6
I	3	3	3	3	2	3
II	3	3	3	2	2	3
III	3	2	3	3	3	2
IV	3	2	3	2	3	2
V	2	2	2	3	2	2

• 1-low, 2-medium, 3-high

MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Numerical Methods						
		Oceanography	3	2	3	2	2	3
		Wave Hydrodynamics	2	3	2	3	3	3
		Marine and Coastal Resources Management	3	3	3	2	3	3
		Marine Pollution Monitoring and Management	3	2	2	3	3	2
		Research Methodology and IPR						
	SEMESTER II	Coastal Engineering	3	3	3	3	2	2
		Satellite Oceanography and GIS	3	2	2	2	3	2
		Marine Surveying and Instrumentation	2	2	3	3	3	3
		Offshore Engineering	2	3	2	3	2	2
		Port and Harbour Engineering	2	2	3	2	2	
		Professional Elective I						
		Coastal Modelling Laboratory	3	2	2	2	2	2
		Integrated Coastal Management Laboratory	2	2	2	2	3	3
YEAR II	SEMESTER III	Professional Elective II						
		Professional Elective III						
		Professional Elective IV						
		Practical Training (4 weeks)	3	3	3	3	3	3
		Project work I	3	3	3	3	3	3
	SEMESTER IV	Project Work II	3	3	3	3	3	3

• 1-low, 2-medium, 3-high

MAPPING OF PROFESSIONAL ELECTIVE COURSES [PEC]

S. No	Course Name	PO1	PO2	PO3	PO4	PO5	PO6
1.	Modeling of Coastal Processes	3	2	2	3	2	2
2.	Coastal Ecosystem and Biodiversity	2	2	2	2	2	3
3.	Fisheries and Aquaculture Technology	3	2	2	2	3	2
4.	Global Climate Change and Oceans	2	3	2	3	2	2
5.	Marine Toxicology	2	2	2	2	2	2
6.	EIA and Ocean Governance	2	3	2	2	2	3
7.	Integrated Coastal Zone Management	2	2	3	3	3	2
8.	Socio-economic aspects of Coastal Management	2	2	2	2	2	2
9.	Coastal Hazards and Management	2	2	3	3	3	2
10.	Deep Sea Technology	2	2	2	3	2	2
11.	Ocean Renewable Energy	2	2	2	3	3	3
12.	Marine Geotechnology	2	2	2	3	2	2
13.	Sustainable Blue Economy	2	3	2	2	2	3

• 1-low, 2-medium, 3-high

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.TECH. OCEAN TECHNOLOGY (FULL-TIME)
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABUS FOR I TO IV SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3155	Advanced Numerical Methods	FC	4	0	0	4	4
2.	OT3101	Oceanography	PCC	3	0	0	3	3
3.	OT3102	Wave Hydrodynamics	PCC	3	0	2	5	4
4.	OT3103	Marine and Coastal Resources Management	PCC	3	0	0	3	3
5.	OT3104	Marine Pollution Monitoring and Management	PCC	3	0	4	7	5
6.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
			TOTAL	**18**	**1**	**6**	**25**	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	OT3201	Coastal Engineering	PCC	3	0	0	3	3
2.	OT3202	Satellite Oceanography and GIS	PCC	3	0	4	7	5
3.	OT3203	Marine Surveying and Instrumentation	PCC	3	0	0	3	3
4.	OT3204	Offshore Engineering	PCC	3	0	0	3	3
5.	OT3205	Port and Harbour Engineering	PCC	3	0	0	3	3
6.		Professional Elective I	PEC	3	0	0	3	3
PRACTICALS								
7.	OT3211	Coastal Modelling Laboratory	PCC	0	0	4	4	2
8.	OT3212	Integrated Coastal Management Laboratory	PCC	0	0	2	2	1
			TOTAL	**18**	**0**	**10**	**28**	**23**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective II	PEC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
PRACTICALS								
4.	OT3311	Practical Training (4 weeks)	EEC	0	0	0	0	2
5.	OT3312	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**17**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	OT3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR AWARD OF THE DEGREE:74 CREDITS

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA3155	Advanced Numerical Methods	4	0	0	4	1
					Total Credits	**4**	

PROFESSIONAL CORE COURSES (PCC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OT3101	Oceanography	3	0	0	3	1
2.	OT3102	Wave Hydrodynamics	3	0	2	4	1
3.	OT3103	Marine and CoastalResources Management	3	0	0	3	1
4.	OT3104	Marine Pollution Monitoring and Management	3	0	4	5	1
5.	OT3201	Coastal Engineering	3	0	0	3	2
6.	OT3202	Satellite Oceanography and GIS	3	0	4	5	2
7.	OT3203	Marine Surveying and Instrumentation	3	0	0	3	2
8.	OT3204	Offshore Engineering	3	0	0	3	2
9.	OT3205	Port and Harbour Engineering	3	0	0	3	2
10.	OT3211	Coastal Modelling Laboratory	0	0	4	2	2
11.	OT3212	Integrated Coastal Management Laboratory	0	0	2	1	2
					TOTAL CREDITS	**35**	

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PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	OT3001	Modelling of Coastal Processes	3	0	0	3
2.	OT3002	Coastal Ecosystem and Biodiversity	3	0	0	3
3.	OT3003	Fisheries and Aquaculture Technology	3	0	0	3
4.	OT3004	Global Climate Change and Oceans	3	0	0	3
5.	OT3005	Marine Toxicology	3	0	0	3
6.	OT3006	EIA and Ocean Governance	3	0	0	3
7.	OT3007	Integrated Coastal Zone Management	3	0	0	3
8.	OT3008	Socio-Economic Aspects of Coastal Management	3	0	0	3
9.	OT3009	Coastal Hazards and Management	3	0	0	3
10.	OT3010	Deep Sea Technology	3	0	0	3
11.	OT3011	Ocean Renewable Energy	3	0	0	3
12.	OT3012	Marine Geotechnology	3	0	0	3
13.	OT3013	Sustainable Blue Economy	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM3151	Research Methodology and IPR	2	1	0	3	1
					Total Credits:	**3**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OT3311	Practical Training	0	0	0	2	3
2.	OT3312	Project Work I	0	0	12	6	3
3.	OT3411	Project Work II	0	0	24	12	4
					Total Credits:	**18**	

SUMMARY

S. No	NAME OF THE PROGRAMME : M. TECH OCEAN TECHNOLOGY					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	4	00	00	00	4
2.	PCC	15	20	00	00	35
3.	PEC	00	03	09	00	12
4.	RMC	03	00	00	00	03
5.	EEC	00	00	08	12	20
	TOTAL CREDITS	**22**	**23**	**17**	**12**	**74**

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MA3155 ADVANCED NUMERICAL METHODS L T P C
4 0 0 4

UNIT I ALGEBRAIC EQUATIONS 12

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, collocation method, orthogonal collocation method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION 12

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, Lax - Wendroff explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme-Stability of above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 12

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD 12

Partial differential equations – Finite element method - collocation method, orthogonal collocation method, Galerkin finite element method.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Get familiarized with the methods which are required for solving system of linear, nonlinear equations and eigenvalue problems.
CO2: Solve the BVPs and the system of IVPs by appropriate methods discussed.
CO3: Solve time dependent parabolic PDEs by using various methodologies up to dimension two.
CO4: Solve elliptic equations by finite difference methods.
CO5: Use the ideas of solving PDEs by finite element method.

REFERENCES:

1. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 3rd Edition, New Delhi, 2015.
3. Jain M. K., Iyengar S. R. K., Jain R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 2nd Edition, New Delhi, 2016.
4. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2005.
5. Sastry S.S., "Introductory Methods of Numerical Analysis", Prentice - Hall of India Pvt. Limited, 5th Edition, New Delhi, 2012.
6. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2
Avg	**3**	**3**	**3**	**3**	**2**	**2**

• 1-low, 2-medium, 3-high

OT3101 OCEANOGRAPHY L T P C
3 0 0 3

UNIT I INTRODUCTION TO OCEANOGRAPHY 9

History and facts about Oceanography - Ocean Floor Topography and Terminology – Layers of ocean - Continental Shelf, Continental Slope, Continental Margin, Continental Rise, Submarine Canyons, Mid Ocean Ridges, Trenches, Abyssal Plains - Various Oceans on Earth, their peculiarities pertaining to geographical, climatic and other aspects.

UNIT II PHYSICAL OCEANOGRAPHY 9

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

UNIT III 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 IV 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 - Respiration - Nekton –Food Chain – Food Web – Bio Geo Chemical Cycle- Marine microbes and microbial Loop - Limiting nutrients in seawater

UNIT V 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 - Palaeoceanography and global climate- Geophysical methods and instruments.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explains about basic knowledge on ocean and its dynamic upwelling, topography, landforms, currents and circulation.

CO2 Summarize the chemical components of the oceans, their reactions, and their pathways of transformation

CO3 Assess the relationship between marine organism and their environment, impact of biotic and abiotic factors on marine ecosystems

CO4 Estimate about different marine sediments, paleo oceanography and different instruments used in oceanographic measurements

CO5 Understand the environment

REFERENCES:

1. Garrison, Tom S, “Oceanography: an invitation to marine science”, Cengage Learning, 2015.
2. Emerson, Steven R., and Roberta C. Hamme. “Chemical Oceanography”, CambridgeUniversity Press, 2022.
3. Webb, Paul, “Introduction to oceanography”, Roger Williams University, 2021.
4. Beer, Tom, “Environmental oceanography”, CRC Press 2nd Edition, 2017.
5. Knauss, John A, and Newell Garfield, “Introduction to physical oceanography”, Waveland Press 3rd Edition, 2016.
6. Savindra Singh, “Oceanography”, Pravalika Publications, 2020

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2	3	2	2
CO2	3	2	2	3	3	2
CO3	3	2	3	3	2	3
CO4	3	2	3	2	2	2
CO5	3	2	2	2	2	3
Avg	**3**	**2**	**3**	**2**	**2**	**2**

• 1-low, 2-medium, 3-high

OT3102 WAVE HYDRODYNAMICS L T P C
3 0 2 4

UNIT I CONSERVATION OF MASS, MOMENTUM AND ENERGY 7

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

UNIT II CLASSIFICATION OF OCEAN WAVES 9

Introduction - wind and waves - Sea and Swell - Introduction to small amplitude wave theory - Mechanics of water waves - Linear (Airy) wave theory, Governing Equation, Boundary Conditions and solutions, Dispersion relation, - use of wave tables, Constancy of wave period. Introduction to Tsunami.

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.

UNIT IV WAVE THEORIES 10

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- Random and directional waves – Demonstration of Wave Flume.

UNIT V WAVE CLIMATE PREDICTION 10

Short term wave analysis- Short term wave Height Distribution – Wave period Distribution- wave energy spectra: Sverdrup-Munk-Bretschneider (SMB) and Pierson-Neumann-JONSWAP (PNJ) spectrum- Time and Frequency domain Analysis of Wave Records- Statistics analysis of grouped wave data –Long term wave analysis– Gumbel Distribution – Weibull Distribution - SWAN and WAVEWATCH models.

LABORATORY EXERCISES 30

1. Introduction and basics of MATLAB
2. Script Files; Functions – Sub functions; Global Variables, Loops, and Branches
3. Arrays and matrices; Importing and Exporting data
4. Graphics; Simple graphs; 2D plots and 3D plots
5. Analysis of wave time series using DSWAP,
6. Analysis of wave time series using OCEANLYZ.
7. Demo on Seagrid, SEA-MAT for bathymetry application
8. Demo on Wave Statistics using WAFO, WAVES
9. Demo on Processing of Waves using ADCP, VMT
10. Demo on Wave Climate using MACE.

TOTAL: 75 PERIODS (45 (Theory) + 30 (Practical))

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the concept of mass, momentum and wave energy transformations.
CO2 Estimate the different classification of ocean waves.
CO3 Explain the wave kinematics, Wave statistics and wave loads along with its properties.
CO4 Estimate the wave forces on structures and applicability of nonlinear wave theories.
CO5 Analyse and forecast the long term and short term waves.

REFERENCES:

1. Boccotti P, “Wave mechanics and wave loads on marine structures”, Butterworth-Heinemann an imprint of Elsevier, 2nd edition, 2015
2. Dominic Reeve, Andrew Chadwick, Christopher Fleming, “Coastal Engineering: Processes, Theory and Design Practice”, Taylor & Francis Group, CRC Press, 3rd edition, 2018
3. Dean, R.G. and Dalrymple, R.A., “Water wave mechanics for Engineers and Scientists”, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, Volume 4, 1994
4. Mani J S, “Coastal Engineering”, PHI Learning Private Limited, 2nd Edition, 2018
5. Pecher, Arthur, and Jens Peter Kofoed, “Handbook of ocean wave energy”, Springer Nature Volume 7, 2017.
6. Sundar, V. “Ocean wave Mechanics- Applications in Marine Structures”, Edition: 1, 2016
7. United States. Army. Corps of Engineers.
8. Washington, D.C. : U.S. Army Corps of Engineers, “Coastal engineering manual”, 2002.
9. World Meteorological Organization, Guide to wave analysis and forecasting.
10. Environmental Data Analysis with MATLAB or Python: Principles, Applications, and Prospects, 3rd edition Author: William Menke, 2022 Publisher: Elsevier.
11. Stochastic Modeling: A Thorough Guide to Evaluate, Pre-Process, Model and Compare Time Series with MATLAB Software, Hossein Bonakdari, Mohammad Zeynoddin, 2022 Publisher: Elsevier Science.
12. Time Series Data Analysis in Oceanography: Applications using MATLAB, Chunyan Li, 2022. Publisher: Cambridge University Press.
13. Wave Energy Devices: Design, Development, and Experimental Studies, Srinivasan Chandrasekaran, Dr. Faisal Khan, Rouzbeh Abbassi, 2022 Publisher: CRC Press, Inc.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	2	3	2	2
CO2	3	3	2	3	2	2
CO3	3	2	2	3	3	2
CO4	3	2		3	3	2
CO5	2		3	3	3	3
Avg	**2**	**3**	**2**	**3**	**3**	**3**

• 1-low, 2-medium, 3-high

OT3103 MARINE AND COASTAL RESOURCES MANAGEMENT L T P C
3 0 0 3

UNIT I MARINE AND COASTAL RESOURCES 9

Estuarine and Mangrove Ecosystem – Soft Sediment Ecosystem – Salt Marsh Ecosystem – Coral Reef Ecosystem – Seaweed Ecosystem – Seagrass Ecosystem - Types and functions of marine and coastal resources - Coastal zone as an integrated resource area -Marine resources: biotic, mineral and energy resources.

UNIT II LIVING RESOURCES 9

Living Marine Resources (LMR) and livelihoods, Managing LMR - Recovery and conservation of protected and endangered species - Marine Protected Areas (MPA) - Large Marine Ecosystems (LMEs).

UNIT III NON – LIVING RESOURCES 9

Marine minerals - Placer deposits - Hydrocarbon deposits - Polymetallic nodules -Extraction of natural minerals - Methyl/ Gas Hydrates - Sea Salt - Seabed mining, Beach sand mining; Renewable energy from the ocean - Hydrocarbons, Gas, Wind, Wave - Tides - Currents – OTEC.

UNIT IV RESOURCE EXPLORATION AND MANAGEMENT 9

Marine geophysical methods – Sea floor resource exploration– Exploitation of the oceans by human activities – overfishing, mining, ocean dumping and oil spills - Coral reef bleaching - 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.

UNIT V BLUE ECONOMY 9

Overview of Blue Economy - SDG - Development of Blue Economy in India and other countries - Blue Economy and Security –Legal Regime for Exploration and Exploitation of Marine Resources - Review of Business opportunities and Constraints in India

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Identify the different coastal and marine resources.
CO2 Describe the Living Marine Resources and its conservation.
CO3 Assess the non-living resources and extract energy from it.
CO4 Apply the knowledge to design appropriate methods to exploration and exploitation of strategies for sustainable management of coastal and marine resources.
CO5 Illustrate the sustainable use of ocean resources for livelihoods and economic growth.

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REFERENCES:

1. Abel, Daniel C., and Robert L. Mc Connell, “Environmental oceanography: topics and analysis”, Jones & Bartlett Publishers, 2009.
2. Kennish, M.J, “Pollution Impacts on Marine Biotic Communities”, CRC Press, New York, 2020.
3. Alongi, Daniel M, “Coastal ecosystem processes”, CRC press, 2020.
4. Scott, Steven D, “Marine minerals: their occurrences, exploration and exploitation”,In OCEANS' 11 MTS/IEEE KONA, pp.1-8. IEEE, 2011.
5. Blue Economy Vision 2025 in India, FICCI Task Force, 2017

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	2	2
CO2	3	3	2	2	3	3
CO3	3	3	3	3	3	3
CO4	3		3	3	3	3
CO5	2	3	3	2	3	2
Avg	**2**	**3**	**3**	**2**	**3**	**3**

• 1-low, 2-medium, 3-high

OT3104 MARINE POLLUTION MONITORING AND MANAGEMENT **L T P C**
3 0 4 5

UNIT I MARINE POLLUTION SOURCES **9**

Marine pollution: Sources of Marine Pollution- Point and Non point sources, kinds and quantities of pollutants entering oceans, Pollution caused by Oil Exploration, Dredging, Offshore structures, ocean dumping - fate of pollutants - toxic effects and nuclear waste disposal- Land based sources of Marine pollution - Emerging Pollutant.

UNIT II MARINE DEBRIS AND HEAVY METAL POLLUTION **9**

Marine Debris-Impacts of Marine litters on Marine Life- Plastics in the marine environment : Plastic, Micro Plastic, Nano Plastics and Sampling Techniques- Prediction of Marine Debris Drifting - Impacts of marine litter on human- Trace metals and Heavy metal as pollutants - Factors influencing the toxicity to marineorganisms.

UNIT III OIL AND THERMAL POLLUTION **9**

Sources and types of oil pollution – Oil Spill - Environmental effects - Cleanup and recovery - Prevention - Environmental Sensitivity Index (ESI) mapping -Thermal Pollution - ThermalEffluents - Major Causes - Effects of Increased Water Temperature - Biotic Effects of Thermal Pollution - Remediation and prevention measure for thermal pollution.

UNIT IV MARINE POLLUTION MONITORING **9**

Methods for the assessment of coastal and marine pollution – pollution monitoring – Water quality parameters: physical/ chemical/ biological properties, sampling techniques and problems – Nutrients, sewage and anoxia –Impacts of heavy metals – Pathways ofradioactivity – Data storage and processing –Water quality standards – Marine Disposal standard (CPCB standards) – ocean monitoring satellites – Applications of remote sensing and GIS in monitoring marine pollution.

UNIT V POLLUTION ABATEMENT PROGRAMS **9**

Environmental Management Plan - preparation, implementation and review – Mitigation and Rehabilitation Plans - Pollution abatement programs in developed countries – case studies. Assessing pollution damage. Law pertaining to marine pollution– Biodegradation and bioremediation.

LABORATORY EXCERCISES **60**

1 Introduction to NABL, introduction to analytical laboratory, Good Laboratory Practices
2 Demo of water quality field kit, Field measurements,
3 Standard procedure for Collection of Water samples, transport and Quality Control.
4 Physical parameters of Marine water sample:
   a) Determination of pH, , EC and Turbidity
   b) Determination of TDS, TSS in Marine water sample
   c) Determination of Salinity Marine water sample
5 Chemical parameters of Marine water sample
   a) Determination of Ammonia,
   b) Determination of Nitrate, Total Nitrogen,
   c) Determination of Phosphate,
   d) Determination of Silicate
6 Heavy metals in the Marine water sample
   a) Determination of Copper and Mercury,
   b) Determination of Arsenic and Lead,
   c) Determination of Zinc and Cadmium
7 Standard procedure for Collection of Water samples, transport and Quality Control.
8 Marine sediment sample Soil Texture by Sieve Analysis
9 Determination of Microplastics in the Marine water and sediment sample.
10 Heavy metals in the Marine Sediment sample
   a) Determination of Copper and Mercury,
   b) Determination of Arsenic and Lead,
   c) Determination of Zinc and Cadmium

TOTAL: 105 PERIODS (45 (THEORY) + 60 (PRACRTICAL))

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain about the various sources of marine pollution.

CO2 Describe about the marine debris and heavy metal pollution and is effects on ocean environment.

CO3 Demonstrate the basic sampling about the sources, effects of oil and thermal pollution in ocean

CO4 Interpret the different marine pollution physical and chemical parameters, monitoring techniques and standards

CO5 Define and prepare the EMP and pollution abutment programs

REFERENCES:

1. Ricardo Beiras, “Marine Pollution sources, fate and effects of pollutants”, Elsevier science, 2018
2. Houma Bachari Fouzia, “Monitoring of Marine Pollution”, Intech Open, 2019
3. R.B. Clark, C. Frid and M Atttrill , “Marine Pollution”, Oxford Science Publications 4th edition , 1997.
4. R.M. Harrison , “Pollution: Causes, Effects & Control”, Royal Society of Chemistry 3rd edition, 1996.
5. M.R.Preston, “Chemical Oceanography - Volume 9”, J.P.Riley ed. Marine Pollution Chapter 20 by Academic Press, 1989.
6. J.D. Strickland and T.R. Parsons, “ A Practical Handbook of Seawater Analysis”, Bull. Fish. Res. Bd, 1972
7. Yuncong Li, Kati Migliaccio, “Water Quality Concepts, Sampling, and Analyses”, Taylor & Francis, 2010
8. Md. Solaiman Hossain, “ Marine Sediment, Water and Fish Contamination by Toxic Elements: Impact on Environment & Human Health Considering Risk Assessment”, Paperback, LAP LAMBERT Academic Publishing 2018.
9. Hrissi K. Karapanagioti; Ioannis K. Kalavrouziotis, “Microplastics in Water and Wastewater”, IWA Publishing Company, 2019.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		1	3	3	2	2
CO2	2	2	2	2	3	2
CO3	3	2	2	3	3	2
CO4	3	2	2	2	2	3
CO5	1	2	3	3	2	2
Avg	**2**	**2**	**2**	**3**	**3**	**2**

• 1-low, 2-medium, 3-high

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,

3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

OT3201 COASTAL ENGINEERING L T P C
3 0 0 3

UNIT I NEAR SHORE WAVE DYNAMICS 9

Introduction - coastal morphology and landforms - Beach, coast and shore -wind, waves, Tides & currents - Sea and Swell – sea level – 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.

UNIT II SEDIMENT DYNAMICS AND BEACH EVOLUTION 9

Sediment Properties – Sediment Transport Mechanism – Characteristics of currents – Sediment Transport under currents – Sediment Transport by Waves and currents – Long shore sediment transport – Cross Shore sediment Transport - Shoreline Changes –Beach Profile change – Equilibrium Beach Profile – Solution for Evolution of Shoreline change.

UNIT III COASTAL STRUCTURES 9

Classification of coastal structures– ports and harbour structures; breakwaters, jetties, etc. Harbour buildings, harbour and marine terminal layout, navigation channels, Power plants; nuclear power plants, desalination plants, Design of Sea water Intakes and outfalls structures, fish landing canters and jetties, Land reclamation by dredged materials, Potential impacts of coastal plants and structures on Marine ecosystem.

UNIT IV DESIGN OF BREAKWATER 9

Types of breakwaters – General design of breakwater structures –Design of Rubble mound breakwater–Weight of the rock armour – Design of Sub-layers – Crest width of the breakwater – Granular Filter – Geotextiles – Scour – Toe Protection – Breakwater failure modes -Wave Run-up for rubble and smooth sloping structure – wave overtopping on Rubble and smooth sloping structure – Design of Crown wall – Wave reflection and transmission characteristics of rubble mound structure.

UNIT V COASTAL PROTECTION STRUCTURES 9

Planning of coast protection works - Design of shore defence structures; Hard Engineering measures- Sea walls, Revetments, Bulkheads, Dikes, Groynes, Breakwaters; Soft Engineering measures – Artificial Reefs, Beach nourishment, Dune regeneration, Salt marsh Creation – Bio-shields - Case studies - Latest technologies in shore protection techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Discuss the concept of near shore wave behaviour and understand the pattern of short term and long-term wave analysis with respect to domains.
CO2 Describe about the sediment dynamics and beach evolution.
CO3 Classify different coastal structure, layout and potential impact on marine ecosystem.
CO4 Design the Breakwater with safety consideration
CO5 Adopt different shore protection structures in order to prevent the shore from erosion.

REFERENCES:

1. Mani J.S, “Coastal Engineering book”, PHI Publishing Company, 2nd Edition, 2021
2. Dean, R.G. and Dalrymple, R.A., “Water wave mechanics for Engineers and Scientists”, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
3. Ippen, A.T, “Estuary and Coastline Hydrodynamics”, McGraw-Hill, Inc., New York, 1978.
4. Sorenson, R.M, “Basic Coastal Engineering”, A Wiley-Interscience Publication New York, 2008.
5. Dioysiosanninos, “Coastal Engineering Manual, Vol. I-VI”, Coastal Engineering Research Centre, Dept. of the Army, US Army Corps of Engineers Publications, Washington DC,2006.
6. William Kamphuis,Introduction to Coastal Engineering and Management
7. Rober M.Sorensen,Basic Coastal Engineering
8. Robert G Dean and Robert A Dalrymple,Coastal Process with Engineering Application
9. Young C Kim, Handbook of Coastal and Ocean Engineering.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	2	2	3	3	3
CO5	3	3	3	2	3	2
Avg	3	3	3	3	3	2

1- Low, 2 – Medium, 3 – High

OT3202 SATELLITE OCEANOGRAPHY AND GIS

L	T	P	C
3	0	4	5

UNIT I REMOTE SENSING **9**

Principles of Remote Sensing - Components - Electro Magnetic Spectrum – Spectral Characteristics – Ocean satellites – Sensors: Passive Sensors – Active Sensors – Ocean parameters – Satellite Altimetry- Oceanographic parameters and Ocean Missions.

UNIT II IMAGE PROCESSING AND CLASSIFICATION **9**

Remote sensing data products – Visual image interpretation – interpretation keys - Digital image processing – Image preprocessing – Image enhancement – Image transformation – image classification – accuracy assessment - Data merging.

UNIT III CARTOGRAPHY **9**

Definition of Map - GOI- Classification based on Function, Scale, Characteristics – Ellipsoid and Geoid – Co-ordinate Systems - Rectangular and Geographic Coordinates – UTM and UPS - Projection – Function - Types of Map Projections – Transformations – Function - Affine transformation - Choice of Map Projection – Evolution of cartography- Geo-Spatial, Spatial and Non-spatial data – Definition of GIS – Evolution GIS – Components of GIS

UNIT IV GIS DATA MODELS AND ANALYSIS **9**

Point, Line Polygon / Area, elevation and surface –Attributes and Levels of Measurement - Data Sources – Ground and Remote Sensing survey – Collateral data collection – Input: Map scanning and digitization, Georeferencing –Raster Vs. Vector Comparison – File Formats for Raster and Vector – Data conversion between Raster and vector - Topology – Geodatabase models: hierarchical, network, relational, object-oriented models – Overlay Analysis, Spatial interpolation, Digital Elevation Model.

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UNIT V OCEANOGRAPHIC APPLICATION 9

Ocean Colour Mapping – Sea Surface Temperature – Sea Surface Topography - Chlorophyll – Carbon Sequestration - Potential Fish Zoning – Oil Spill Monitoring – Ship Navigation – Case Studies. Marine Spatial Planning - Methodologies for Defining Habitats - Mapping Coral Reefs, Macroalgae, Mangrove and Wetlands - Coastal Landuse/Land Cover Mapping - Coastal Geomorphology – Shoreline Changes – CRZ Mapping – Coastal Hazard and Vulnerability Mapping

LABORATORY EXERCISES 60

Remote Sensing

1. Remote sensing – history & development, definition, concept and principles
2. Satellites and their characteristics - Satellite data products: commercial and open source
3. Sensors – types and their characteristics
4. Image classification : Land use and land cover
   Unsupervised Classification : Pattern recognition and image classification
   Supervised classification - training site selection, classifiers used in supervised
5. Map reading Survey of India topo sheets.
6. Data Conversion – Vector to Raster, raster to Vector
7. Exploring Sea Surface Temperature with MODIS, Multi Beam Grid

Geographical Information System

8. Georeferencing of toposheet and creating vector layers
9. GIS Entities and Feature Data Base– Point features, Line features, and Polygon features
10. Transformation of Data from Google earth to GIS Environment & Excel sheet to GIS Environment
11. DEM analysis using ArcGIS
12. Analysis of spatial information- Clip – Buffer - Overlay
13. Interpolation of Point data to create Spatial Maps
14. Mapping of Sea Surface Temperature
15. Mapping of Sea Surface Height
16. Mapping of Shoreline changes

TOTAL: 105 PERIODS (45 (THEORY) + 60 (PRACTICAL))

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the physical principles of remote sensing and Ocean Satellites.
CO2 Interpret and analysis of Digital Image Processing.
CO3 Understand the Characteristics and Components of Maps and GIS
CO4 Explain the basic data structures and analyses in GIS
CO5 Summarize to use oceanographic applications of satellite remote sensing

REFERENCES:

1. Lillesand, T.M. and Kieffer R.W, “Remote Sensing and Image Interpretation”, John Wiley& Sons, U.S.A, 2015.
2. Burrough, P.A and McDonnell R.A., “Principles of Geographic Information Systems”, Oxford Press, U.K, 2015.
3. Green, E.P., Mumby, P.J., Edwards, A.J. and Clark, C.D, “Remote Sensing Handbook for Tropical Coastal Management - Coastal Management Sourcebooks” Edwards A.J., UNESCO Publishing, France 3rd edition, 2000.
4. John A. Richards, “Remote Sensing Digital Image Analysis”, Springer, 2022
5. Maul, George A, “Introduction to satellite oceanography”, Volume. 3. Springer Science & Business Media, 2012.
6. Martin, Seelye, “An introduction to ocean remote sensing”, Cambridge University Press, 2nd Edition 2014.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	2	2	3	2
CO2	3	2	2	2	3	3
CO3	3	2	2	2	2	2
CO4	3	2	3	2	2	3
CO5	3	2	3	2	3	3
Avg	3	2	2	2	2	2

1- Low, 2 – Medium, 3 – High

OT3203 MARINE SURVEYING AND INSTRUMENTATION L T P C
3 0 0 3

UNIT I BASICS OF SURVEYING 9

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 - Survey of India - Topographic surveying applied to hydrography- Global Positioning systems (GPS) - Electronic Distance Measurements- RTK measurements

UNIT II SEA SURVEYING 9

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 – Bathymetry Surveying equipment: echosounder, multibeam sonar, Seismic - sub-bottom profiler, side scan sonar, and tracking equipment - Plotting and measurements from Sonar records - Multi beam Echo sounders - Featuredetection and Sea floor classification - Nautical charts - Nautical Information Systems.

UNIT III COASTAL SURVEYING 9

Modern instrumentation - Total station, Drones and Satellite telemetry system -LIDAR surveying for Digital Elevation Models (DEM) – Fields of applications and uses - large scale coastal land surveying - Beach Profile - Hydrographic surveys for coastal regions - Delineation of high tide, low tide and coastline and demarcation – Coastal Surveillance.

UNIT IV METOCEAN OBSERVATION 9

Metocean – Types of buoys - Sensors - Measurement of meteorological parameters: wind, air temperature, solar radiation, pressure, humidity – Physical Oceanography parameters : Wave height, direction, tidal height, tidal period and ocean depth - Environmental parameters: conductivity, temperature, pH, salinity, dissolved oxygen, turbidity, sediments, chlorophyll, fluorescence and pollution - Real time data Transmission by radio, GPRS, GSM, satellite or AIS toa Control Centre-Accuracy and reliability.

UNIT V TIDAL AND CURRENT MEASUREMENTS 9

Principles of Tides and Water Levels - Astronomical Tide Producing Forces - Tidal Characteristics - Non-tidal water level variations - Tide and water level Datum - Types of tide gauges: principles and operation Harmonic Analysis and Tide Prediction - Principles of Tidal Currents - Measurements and Prediction of Currents and wave measurements.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the basics information of shapes of earth, coordinate systems, cartography, Projection and its types.

CO2 Apply the modern electronic instruments for sea surveying

CO3 Explain the modern instrumentational methods in coastal survey.

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CO4 Estimate the different types of buoys, sensors and its use for the application and operations for measurement of wind, temperature, current, wave height and direction

CO5 Extend the knowledge of Tides and currents

REFERENCES:

1. Ask, T., "Handbook of Marine Surveying", Sheridan House, 2nd edition, 2007.
2. Ghilani, C.D. and Wolf, P.R., "Elementary Surveying: An Introduction to Geomatics", Published by Prentice Hall 13th Edition, 2011.
3. Kennish, M.J, "Practical Handbook of Marine Science", CRC Press 4th Edition, 2001.
4. Brekhovskikh, L.M. and Lysanov, Y.P, "Fundamentals of Ocean Acoustics", Springer 3rd edition ,2004.
5. Dean, R.G. and Dalrymple, R.A, "Coastal Processes with Engineering Applications", Cambridge University Press, 2002.
6. WilliamJ.Emrey and Richard E. Thomson, "Data Analysis methods in Physical Oceanography", Elsevier 3rd edition, 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		1	3	2	2
CO2	2	2	2	3	3	3
CO3	2	2	3	3	2	2
CO4	3	2	3	3	2	2
CO5	3	3	3	3	3	3
Avg	**2**	**2**	**3**	**3**	**3**	**3**

1- Low, 2 – Medium, 3 – High

OT3204 OFFSHORE ENGINEERING L T P C

3 0 0 3

UNIT I OFFSHORE STRUCTURES 7

Introduction – Definition of Offshore Structures–Functions of Offshore Structures – Exploratory Drilling Structures – Production Structures – Storage Structures – Export Systems- Offshore Structures Configurations– Floating vs Fixed Offshore Structures.

UNIT II MARINE SEDIMENTS AND SAMPLING TECHNIQUES 7

Planning and site exploration - marine sediments classification and its properties. Consolidation and shear strength characteristics of marine sediments. Sampling techniques - Drilling, Laboratory testing, In situ testing methods and geophysical methods. Current design practices of marine foundations.

UNIT III DESIGN OF FIXED OFFSHORE PLATFORM 12

Field Development and Concept Selection – Introduction –Field Development Design Phase– Basic and Analysis and design of a Fixed jacket- Platforms– and Gravity Base Structures – offshore jacket structures. Overview of design softwares

UNIT IV DESIGN OF FLOATING OFFSHORE PLATFORM 12

Introduction – Floating Platforms - Types – Functional Requirements –– Floating Production Storage and Offloading Systems (FPSO)– Deepwater production Risers & Mooring systems – Stability.

UNIT V OFFSHORE OIL AND GAS PIPELINE DESIGN 7

Offshore oil and gas exploration - Geology – Geophysical Survey- Pipeline elements-types of pipelines-laying method-materials- Pipe wall thickness verification- Isopach – Alignment- Pipeline stability- Design using DNV 81 code.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Describe the overview of site exploration of marine sediments and sampling techniques.

CO2 Understand the basic principles of Offshore structures Technology.

CO3 Learn about the concepts of fixed offshore platform design factors

CO4 Enumerate the design principles of offshore floating systems.

CO5 Explain the concepts of oil and gas exploration and to study about the subsea Pipelines Installation & maintenance

REFERENCES:

1. Subrata K. Chakrabarti, "Handbook of Offshore Engineering –1", Elsevier publication, Edition 2006.
2. D Faulkner; M J Cowling, "P A Frieze, "Integrity of offshore structures", Publisher,Englewood, N.J., Applied Science,1991
3. Planning, Designing, and Constructing, Fixed Offshore Platforms—Working Stress Design,API RECOMMENDED PRACTICE 2A-WSD, 22nd Edition, November 2014
4. Structural Integrity Management of Fixed Offshore Structures, API Recommended Practice 2SIM, First Edition, November2014

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	3	2
CO2	2	3	3	2	2	2
CO3	3	3	3	3	3	3
CO4		2	2	3	2	2
CO5	3	3	2	3	3	2
Avg	**2**	**3**	**2**	**3**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3205 PORT AND HARBOUR ENGINEERING L T P C

3 0 0 3

UNIT I PORTS AND HARBOUR 7

History - Development of Port and Harbour - Classification of ports and harbours - Natural ports and manmade ports, major ports, minor ports, Green ports and harbours, Global trade and port restructuring/reforms along with sustainability, sustainable development strategies.

UNIT II DESIGN OF PORTS 10

Port designs and layouts - Design of port infrastructures with regards to cargo handling , cargo storage and integrated transport of goods - planning multipurpose port terminals – Port Modernization and development of new port – SAGARMALA Project.

UNIT III DESIGN OF HARBOUR 11

Design of harbour Infrastructures -Breakwaters, jetties and quay walls - design of break water - shore attached and offshore breakwaters design - design of harbour basin, approach channel, and turning basin, harbours and passenger terminals. Fisheries harbours: Passenger terminals and Cargo terminals - Design issues: Modeling of harbour layout with regards to wave action, hydrodynamic conditions, siltation, navigability and berthing facilities – Numerical Modelling studies for impact of possible climate change scenarios against waves, tides, currents and sea levelrise.

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UNIT IV WATERWAYS OF PORT AND HARBOUR 8

Transportation - Maintenance of waterways, harbour layout - Safe and efficient vessels navigation, cargo loading and unloading- Navigation channels and dredging -Capital and annual Dredging – Dredging equipment - Dredging for navigation improvement, pipelines and cables, soil replacement.

UNIT V PORTS AND HARBOURS OPERATIONS 9

Introduction, Design of wave conditions, tidal condition, navigational depths - Capital dredging, and annual dredging for cargo handling - Human safety on quays, swells and breakwaters - VTMS (Vessel-Traffic-Management-System) - Design of wave conditions -Hind casting/ nowcasting /Forecasting /of wave and current conditions for port operations

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Describe the basic principles of design of port and harbour structures.

CO2 Design the harbour Infrastructures with multipurpose ports and harbours terminals, passenger terminals.

CO3 Understanding the Maintenance of waterways, Port and harbour layout for safe andDredging for navigation improvement, reclamation, pipelines and cables, soil replacement.

CO4 Analysis the basic operations of port and harbour and to design wave conditions for forecasting / nowcasting / hind casting of wave and current conditions for port operations

CO5 Explain the construction, maintenance and renovation aspects of ports and sustainable development strategies for coastal cities and ports

REFERENCES

1. Muir Wood, A.M., and Fleming. C.A., “Coastal Hydraulics Sea and Inland Port Structures”, 1st Edition, Hallstead Press, 2002.
2. Ozha & Ozha, “Dock and Harbour Engineering”, 1stEdition, Charotar Books, Anand., 1990
3. A.D. Qinn, “Design and construction of Ports and Marine Structures”, McGraw-Hill, 1971.
4. Gregory Tsinker, “Handbook of Port Harbour Engineering: Geotechnical and structuralaspects”, PHRI Research Institute 2014 .
5. Ben C. Gerwick, “Construction of marine and offshore structures”, CRC Press Tayler and Francis group, 2007.
6. R.N. Bray,.A.D. Bates and J.M. Land, “Dredging: A Handbook for Engineers”, John Wiley & Sons, 2nd edition, 2002
7. Hans Agershou: Thomas Telford, “Planning and Design of Ports and Maritime Terminals” 2nd Edition, 2004
8. Per Bruun, “Port Engineering”, Gulf Publishing Company 3rd edition,1981

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2		2	2	3
CO2	2		3	3	3	3
CO3	2	2	3	3	2	2
CO4	3		3	2	2	3
CO5		3	2	2	2	3
Avg	**2**	**2**	**3**	**2**	**2**	**3**

1- Low, 2 – Medium, 3 – High

OT3211 COASTAL MODELLING LABORATORY L T P C
0 0 4 2

EXERCISES:

A.Physical Modeling

1. Demonstration of Wave flume
2. Calibration of Wave Flume
3. Determination of Reflection Coefficients

B. Numerical Modeling

1. Introduction to open-source models STWAVE, CGWAVE, DELFT 3D, REEF 3D
2. Overview of marine hydrodynamic Model
3. Creating computational mesh
4. Creating mdf-file from raw xyz data
5. Adjusting boundary data into a domain and triangulation of the domain
6. Variety of Hydrographic Boundary Conditions
7. Hydrodynamic Setup
8. Creating the bathymetry file
9. Creating the Input parameters: Wave condition, Wind conditions, Current Condition
10. Model Setup – Flow Model – Model Calibration – Model extraction
11. Compare model results and measured values using post processing softwares like TEC plot.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the knowledge on modelling application used in softwares

CO2 Relate the valuable information gained on modelling operations and environment.

CO3 Understand pre and post processing procedure.

REFERENCES:

1. Chapra, S.C. and Canale, R.P, “Numerical Methods for Engineers”, Tata McGraw Hill Publishing Co. Ltd. 7thEdition, 2006.
2. Chapra, S.C, “Surface Water Quality Modeling”, McGraw Hill Companies, Inc.1997.
3. Reeves, D., Chadwick, A. and Fleming, C, “Coastal Engineering”, Spon Press, 2004.
4. Dean, R.G. and Dalrymple, R.A, “Water wave mechanics for Engineers and Scientists”, Prentice-Hall, Inc., Englewood Cliffs, New Jersey,1994.
5. Ippen, A.T, “Estuary and Coastline Hydrodynamics”, McGraw-Hill Book Company, Inc. New York,1978.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3	2	3
CO2	2	2	2	2	2	2
CO3	3	2	2	2	3	3
Avg	**3**	**2**	**2**	**2**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3212 INTEGRATED COASTAL MANAGEMENT LABORATORY L T P C
0 0 2 1

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.

EXERCISES :

1. The Need for ICM
2. Examples of Interactions among Coastal and Ocean Uses and Their Environments
3. Goals, Functions, Principles and Stages in Developing an ICM Program
4. ICM and CRZ (Latest notifications).
5. Pathway through the framework
6. Stakeholder analysis
7. Problem tree analysis
8. Resource survey
9. Focus group discussions
10. Environmental assessment

TOTAL: 30 PERIODS

COURSE OUTCOME:

CO1: Identify natural, engineering and human components on the coast; functions of components and relationship between them.

CO2: Analysis of identified coastal issues to determine appropriate approaches and research survey tools in coastal and marine management.

CO3: Interpret and communicate effectively in oral 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. Ramesh, R. and Purvaja, R., E-learning module on ICZM for UNESCO-IHE, The Netherlands, 2006.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	3
CO2	2	2	2	3	3	3
CO3	2	2	2	2	3	3
Avg	**2**	**2**	**2**	**2**	**3**	**3**

1- Low, 2 – Medium, 3 – High

OT3311 PRACTICAL TRAINING (4 Weeks) L T P C
0 0 0 2

SYLLABUS:

The students individually undertake training for a minimum period of four weeks in reputed organizations during the summer vacation or they can participate training programmes organized by Anna University for a minimum period of four weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the third semester. The students will be evaluated through a viva-voce examination.

COURSE OUTCOME:

CO1: Understand the practical problems related to Marine and Coastal Management in carrying out engineering tasks

CO2 : Develop the skills in facing and solving the field problems.

CO3 : Solve the practical field/industry orientated problem related to Ocean Technology, Coastal Engineering and Coastal Management.

CO - PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

1- Low, 2 – Medium, 3 – High

OT3312 **PROJECT WORK I** **L T P C**
0 0 12 6

SYLLABUS:

A research project topic may be selected either from emerging areas or from the creative ideas of the students themselves in consultation with their project supervisor to improve the student research and development activities. The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

COURSE OUTCOME:

CO1: Identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
CO2: Collect the literatures and case studies for their research identified problems
CO3: Develop the methodology to solve the identified problem.

CO - PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
Avg	3	3	3	3	3	3

1- Low, 2 – Medium, 3 – High

OT3411 **PROJECT WORK II** **L T P C**
0 0 24 12

SYLLABUS:

The student may continue the Project work I on the selected topic as per the formulated methodology or they can choose the new project based on Industry/ Company requirements. They solve the identified problem based on the formulated methodology. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Division. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Division based on oral presentation

and the project report. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

COURSE OUTCOME:

CO1: Generate factual results of their applied research problems in Coastal and Ocean Technology.

CO2: Develop skills in research and development activities.

CO3: Summarize the results and conclude the solutions and recommendations.

CO - PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
Avg	3	3	3	3	3	3

1- Low, 2 – Medium, 3 – High

PROFESSIONAL ELECTIVE COURSES

OT3001 MODELLING OF COASTAL PROCESSES L T P C
3 0 0 3

UNIT I INTRODUCTION TO TYPES OF MODELS 12

Types of models, Physical models-Purpose- Geometric, Kinematic and Hydrodynamic Similitude, Froude- Reynolds and Cauchy Models. Empirical models, Analytical models, Numerical models-Introduction to FEM/finite difference and mesh free models, Boundary conditions-Neumann and Dirichlet Boundary conditions, periodic boundary, Stability criteria for models.

UNIT II HYDRODYNAMIC AND SEDIMENT MODELLING 9

Basic principles of marine hydrodynamics - Bed Resistance and Wind Forcing, Wave equation – shallow water wave equation and their solutions. Sediment modelling: Sediment Characteristics-Sediment distributions - Boundary conditions- Movement of sediment by water flows - Movement of sediment by the wind – Bed Configurations-Sediment transport.

UNIT III WATER QUALITY AND ECOLOGY MODELLING 8

Water Quality Modelling -Mass Balance for a well-mixed system - Steady State & Time dependent solution to a well-mixed system - Modelling Feed-forward & Feedback systems - Advection and Diffusion - water quality response to inputs - Introduction to Ecological Models- Model development and validation

UNITIV TSUNAMI MODELLING 8

Tsunami: Interpretation of Seismic Records - acceleration, velocity and displacement; Frequency and Time Domain parameters- Epicentre and magnitude determination - Earthquake induced Tsunami hazard - Consideration for Tsunami hazard mapping.

UNITV STORM SURGE MODELLING 8

Storm surge: basic metrological disturbance, reasons occurrence of cyclone, movements of cyclones in northern and southern hemisphere – Bathymetry -delamination of cyclonic track - wind speed -intensity of cyclone – raise in water level & storm surge – impacts in low laying areas and river mouths –inundation and association with rain - Rain dominated event - Surge dominated event– Storm surge modelling.

TOTAL :45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Define the basic numerical tool used in modelling.

CO2 Perform hydrodynamic and sediment modelling based on governing equations of wavesand sediment.

CO3 Synthesize water quality and ecology modelling based on time, advection, diffusion andquality response.

CO4 Investigate Tsunami Modelling and interpret using seismic records.

CO5 Evaluate Storm surge modelling based on meteorological factors like bathymetry, windspeed, intensity of cyclone and precipitation.

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. NewYork, 1978.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	2
CO2	3	2	2	3	2	2
CO3	2	2	3	3	2	3
CO4	2	2	2	3	3	2
CO5	3	3	3	3	2	3
Avg	**3**	**2**	**2**	**3**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3002 COASTAL ECOSYSTEM AND BIODIVERSITY L T P C
3 0 0 3

UNIT I COASTAL ECOLOGY AND BIODIVERSITY 9

Fundamentals of Ecology - Basic Ecological principles - Energy and Nutrient Relations Thermodynamics - Population distribution, dynamics and growth - Competition, predation, mutualism Food web, trophic transfer - Classification of Coastal ecosystems - mangroves - tidal flats - seagrass beds - coral reefs - Ecosystem services – Coastal biodiversity - Importance of coastal and marine biodiversity.

UNIT II 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 III RESOURCE MANAGEMENT 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 - Ecotourism

UNIT IV COASTAL BIODIVERSITY THREATS 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 V 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

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Discover the Importance of Coastal Biodiversity and different ecosystems provided bymarine environment

CO2 Understand the methodology for assessing, monitoring and conserving biodiversity in various Coastal and Marine ecosystems

CO3 Manage the resources according to indigenous and traditional knowledge in conservation practices.

CO4 Determine the various threats on Coastal Biodiversity.

CO5 Analysis the national policies and legislation for managing the 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. Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions, Montreal, Technical Series No. 67,2012.
7. Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guide. UNEP.
8. Peter J. S. Jones, Wanfei Qiu, Elizabeth De Santo, “Governing Marine Protected Areas - Getting the balance right”, Technical Report. UNEP, 2011.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	2	3
CO2	2	2	2	2	3	3
CO3		2	2	2	3	3
CO4	2	2	2	2	2	2
CO5	2	2	1	2	2	2
Avg	**2**	**2**	**2**	**2**	**2**	**3**

1- Low, 2 – Medium, 3 – High

OT3003 FISHERIES AND AQUACULTURE TECHNOLOGY L T P C

3 0 0 3

UNIT I BASICS AND FUNDAMENTALS OF FISHERIES 9

Introduction of Marine Fisheries – Major and Minor marine fisheries of the world and particularly India. Classification of marine fisheries, Current status of Indian capture and industrial fisheries - Fishery resource of EEZ of India. Methods of surveying the fishery resources – Sampling of feed up on small marine organisms like copepods, acoustic method and aerial method, potential fishing zone method.

UNIT II FISHING GEAR AND CRAFT TECHNOLOGY 9

Classification of Fishing Gear – Fishing Gear Materials – Modern Fishing gears – Trawls, Gill, Nets, Longlines Fishing Gear Accessories – Fishing Crafts of Indian Coast – Wooden boat construction –Steel boat construction – FRP boat Construction -Dry docking– Boat building yards, Development ofFisheries harbour, Fish landing jetties.

UNIT III FISHERY ECONOMICS & FISHERIES RESOURCE MANAGEMENT 9

Basic of Economics Theories of demand, supply– Types of market - Marketing channels in Fisheries- Principles and objectives of co-operation-Fisheries Co-operatives- Role of NABARD, NFDB, MPEDA, FISHCOFED in fisheries development - Fisheries legislation: Overview of fisheries and aquaculture legislations in World and India -CCRF-UNLCOS - Indian Fisheries Act, 1897, CRZ, Marine Fisheries Regulations of different states- Ecosystem approach for fisheries management.

UNIT IV AQUACULTURE 9

History of aquaculture – Global coastal aquaculture development and management – General Principles - Infrastructural facilities and Human resources – Water resources and quality for aquaculture and management - Survey and Selection of suitable sites – Site selection for aquaculture using remote sensing and image processes techniques - Selection of cultivable species – Exotic species for aquaculture, Water discharges problems from aquaculture pond post-harvest of fishes.

UNIT V AQUACULTURE TECHNOLOGIES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Classify fisheries resources of the world and Indian fisheries.
CO2 Understand types of gear and craft used for fishing.
CO3 Explain the fisheries economics and resource management
CO4 Learn about coastal aquaculture development and management, Site selection for aquaculture using remote sensing.
CO5 Gain the knowledge on Fin fish and shellfish seed production technology, by-products, preservation and processing Technology.

REFERENCES:

1. Dholakia, A.D., “Fisheries and Aquatic resources of India”, Daya Publishing House, Delhi, 2004
2. Bal, D.V. and K.V. Rao, “Marine Fisheries of India”, Tata McGraw Hill Publishing Company Limited, New York,1990.
3. Mohan Joseph,M.and A.A.Jayaprakash, “,Status of exploited marine fishery resources of India”, CMFRI, ICAR, Kochi, 2003
4. Egna, H.S. and Boyd,C.E, “Dynamics of Pond Aquaculture”, CRC Press. New York, USA, 1997.
5. Lucas, J.S. and Southgate P.C, “Aquaculture – Farming aquatic animals and plants”, Fishing News Books, Blackwell Publishing Ltd. Oxford, UK, 2003.
6. Lawson, T.B, “Fundamentals of Aquacultural Engineering”, CBS Publishers & Distributors. New Delhi, 1997.
7. Stickney, R.R. and McVey, J.P, “Responsible marine aquaculture”, CAB Publishing, New York, USA, 2002.
8. Thomas, P.C, “Current and Emerging Trends in Aquaculture”, Daya Publishing House, New Delhi, 1998.

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CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	1	2	3	2
CO2		2	1	2	2	2
CO3	3	2	2	3	2	2
CO4	3	2		2	3	2
CO5	3	2	2	3	3	2
Avg	**3**	**2**	**2**	**2**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3004 GLOBAL CLIMATE CHANGE AND OCEANS L T P C

3 0 0 3

UNIT I CLIMATE CHANGE 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 Circulation -currents - Thermohaline circulation - El Nino and La Nina- and deep water masses - Ocean heat budgets and water mass mixing - Cryosphere.

UNIT III CLIMATE CHANGE MODELLING 9

The IPCC Assessment Reports - AR5 and AR6 reports -Indicators of climate change - Global Warming- Sea Surface Temperature (SST) - Sea Level Rise (SLR) - RCP and SSP Scenarios – General Circulation Model (GCM) - Regional Circulation Model (RCM) - Statistical and Dynamic Downscaling-CMIP and CORDEX Models-Sea Level Projection- SimCLIM model - Projection of future scenarios

UNIT IV IMPACTS OF CLIMATE CHANGE 10

Oceans- Heat - Sea Surface Temperature (SST)- Coral bleaching – OceanAcidification - Ocean productivity - Snow and Ice Ecosystems - Sea Level Rise (SLR) - Coastal flooding - Industry-coastal tourism, retail and Commercial services - health effects -livelihood impacts, displacement, distributional impacts within and among coastal cities – Marine Insurance.

UNIT V ADAPTATION AND MITIGATION 9

Mitigating climate change - Blue Carbon- Carbon Sequestration - Geoengineering - renewable energy and other alternate systems - adaptation of indigenous knowledge - Sectoral adaptations - coastal ecosystems - coastal communities- main streaming climate change into development practices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the basics of climate change, its past climate, variability of climate in decades
CO2 Relate the roles of ocean in climate, circulation patterns and its interaction withatmosphere
CO3 Classify the various impacts with reference to climate change
CO4 Asses the various climate change scenario
CO5 Demonstrate the adaptation and mitigation practices in climate change

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REFERENCES

1. Subrata K. Chakrabarti, “Handbook of Offshore Engineering – 1”, Elsevier publication, Edition 2006.
2. D Faulkner; M J Cowling, “P A Frieze, “Integrity of offshore structures”, Publisher, Englewood, N.J., Applied Science,1991
3. Planning, Designing, and Constructing, Fixed Offshore Platforms—Working Stress Design, API RECOMMENDED PRACTICE 2A-WSD, 22nd Edition, November 2014
4. Structural Integrity Management of Fixed Offshore Structures, API Recommended Practice 2SIM, First Edition, November2014

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	2	2
CO2	2	3	3	2	2	2
CO3	3	3	3	3	3	3
CO4		2	2	3	2	2
CO5	3	3	2	3	3	2
Avg	**2**	**3**	**2**	**3**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3005 MARINE TOXICOLOGY L T P C
3 0 0 3

UNIT I ENVIRONMNETAL TOXICOLOGY 9

General Principles of Toxicology and Ecotoxicology, The Necessity of Measurement and Determination of Toxicity, Pollution and Routes of Entry, Factors in Testing for Environmental Effect, Test Systems and Study Types for Ecotoxicology, Environmental Assessment of Agrochemicals, Environmental Assessment of Pharmaceuticals, Pitfalls in Environmental Toxicology.

UNIT II AQUATIC TOXICOLOGY 9

Aquatic Toxicology : Causes of Aquatic Contamination, Sources and Transport of Chemicals in Aquatic Systems, The Most Important Experimental Designs and Organisms in Aquatic Toxicology, Factors Affecting the Bioavailability of Chemicals, Chemical Uptake by Organisms, Chemical Distribution in Organisms, Excretion of Compounds from Organisms Interactions between Chemicals , Bioindicators and Biomarkers Acute and Chronic Toxicity, Effects of Chemicals on Aquatic Populations, Effects of Chemicals on Aquatic Communities and Ecosystems

UNIT III MARINE ECOTOXICOLOGY AND TOXICANTS 9

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

UNIT IV RISK ASSESSMENT 9

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.

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UNIT V CASE HISTORIES AND ECOSYSTEM SURVEYS 9

Sources, Pathways, and Effects of PCBs, and heavy metals, The Chernobyl Nuclear Power Plant Reactor Accident, Pesticides, The Hudson River — PCB Case Study

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1 Describe about the principles of toxicology

CO2 Illustrate the basic principle of aquatic toxicology

CO3 Determines the toxicity of various pollutants and the ultimate fate of pollutants in marine organisms;

CO4 Estimate the risk assessment of contaminants on communities and ecosystems

CO5 Understand the impact of toxicants

REFERENCES:

1. Barnes, R.S.K. and Hughes, R.N, "Introduction to Marine Ecology", Blackwell Publishing, 3rd Edition, 1999.
2. David J. Hoffman, BarnettA. Rattner, G Allen Burton, Jr, John Cairns Jr., "Handbook of Eco-toxicology", CRC Press Company 2nd edition, 2003.
3. Kaiser, M.J., Attrill, M.J., Jennings, S., Thomas, D.N., Barnes, D.K.A., Brierley, A.S., Polunin, N.V.C., Raffaielli, D.G., Williams, P.J. le B, "Marine Ecology: Processes, Systems, and Impacts", Oxford University Press, New York, pp557, 2005.
4. Klaassen, Curtis D. Casarett and Doull's, "Toxicology - The Basic Science of Poisons", McGraw-Hill 7th Edition, 2008.
5. Wright, D.A., Welbourne, P, "Environmental Toxicology", Cambridge University Press, 3rd Edition, 2002.
6. Mount, D.R. and T.R. Henry, "Ecological Risk Assessment. In: The Toxicology of Fishes", R.T. DiGiulio and D.E. Hinton, Eds., Taylor & Francis, Boca Raton, FL, pp.757-775, Chapter 18, 2008.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	3	2
CO3	2	2	2	3	2	3
CO4	3	3	2	2	2	2
CO5	3	3	3	3	3	2
Avg	**2**	**2**	**2**	**2**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3006 EIA AND OCEAN GOVERNANCE L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Principles of EIA, EIA Requirements; Environment related legislation in India - Legislation for EIA, Coastal regulations, Environmental clearance.

UNIT II COMPONENTS AND METHODS 9

Assessing impacts on Terrestrial and Marine environment and on Society - Air, Noise, Water, Soil, Ecology and Biodiversity 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 - Ocean Technology 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, Offshore Structures & Submarine Pipelines - coastal power plants, intake and Outfalls, thermal impacts on marine ecosystem -desalination plants – Shore protection standards - mitigation and management of impacts on the coastal and marine ecosystems.

UNIT V OCEAN GOVERNANCE 9

Law of the Sea [UNCLOS] – Ocean Governance – Environmental policies – Spatial planning – Administrative and legal situations, New and innovative policies for governing oceans and seas - marine resources- Existing national and international institutions for marine governance –Concept of EEZ- Coastal Regulation Zone, CRZ - I, CRZ- II CRZ- III CRZ- IV, Critical Issues In Context Of CZM, Integrated Coastal Zone Management Plan and EIA notifications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the fundamentals of EIA requirements including EIA legislation in India
CO2 Assess the impact on environment for decision making process.
CO3 Describe the various procedure involved in quality control and institutional arrangement.
CO4 Apply EIA methodologies as well as knowledge of science and engineering in preparing EIAfor different sectors
CO5 Understand the various law and ocean governance in CRZ for proper development of ICZM plan

REFERENCES:

1. John Glasson, RikiTherivel and Andrew Chadwick, “Introduction to Environmental Impact Assessment”, The Natural and Built Environment series 4th Edition, 2019.
2. Dwi Abad Tiwi, “Improving environmental impact assessment for better integrated coastal zone management”, Taylor and Francis, 2003.
3. Integrated EIA 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 websitewww.envfor.nic.in
6. Environmental impact assessment and monitoring in aquaculture. FAO Fisheries and Aquaculture Technical Paper. No. 527. Rome, FAO. 2009.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	2	2	2	2
CO2	1	2	2	2	2	2
CO3	2	2	2	3	3	2
CO4	1	2	3	3	2	2
CO5		2	3	2	3	2
Avg	**1**	**2**	**2**	**2**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3007 INTEGRATED COASTAL ZONE MANAGEMENT L T P C
3 0 0 3

UNIT I FUNDAMENTAL CONCEPTS OF ICZM 9

Introduction: The Coasts – Unique, Valuable and Threatened –Interactions of Coastal and Ocean Environments – Early Efforts at Coastal Management - The Needfor ICM – CRZ Notification.

UNIT II ICM FRAME WORK AND PROCESSES 9

Introduction – What is ICM – Developing an ICZM framework - Principles – Goals – defining boundaries - Identification and Prioritizing issues - Stages in Developing an ICZM Program - Pathwaythrough the framework.

UNIT III ICZM TOOLS AND TECHNIQUES 9

Administrative tools – policy and legislation, zoning, regulation and enforcement, spatial planning, marine spatial planning; Research methods: Rapid rural appraisal(RRA), Participatory rural appraisal(PRA),Participatory learning and action(PLA) , Social tools: Stakeholder analysis, conflict resolution, customary practices, capacity building – Technical tools: strategic environmental assessment, risk assessment and evaluation, cost benefit analysis, problem tree analysis.

UNIT IV COASTAL REGULATIONS 9

Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands - Problem and objective analysis– Developing indicators for Monitoring and evaluation, adaptive management. Remote sensing and GIS for spatio -temporal variations in CRZ Mapping , Changes in the extent and ecology of coastal ecosystem.

UNIT V COASTAL LAWS, POLICIES, INSTITUTIONS AND GOVERNANCE 9

Introduction to Environmental Law and Policy - Laws and policies dealing with environment and coast– Institutions for ICZM. International Law and Policy - Law of the Sea [UNCLOS] - Institutions and Governance Mechanisms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain the basic fundamentals of ICZM
CO2 Develop ICZM framework based on various processes.
CO3 Assess the risk by using various tools and technique in ICZM
CO4 Explain on Coastal Regulations
CO5 Determine the international and national legislation and their role in coastal management

REFERENCES:

1. Cicin-Sain, B and Knecht, R.W, “Integrated Coastal and Ocean Management: Concepts and Practices”, Washington, DC, Island Press,1998.
2. Kay, R and Jackie Alder, “Coastal Planning and Management”, Taylor and Francis.2005
3. Clark, J.R, “Coastal Zone Management Handbook”, CRC Press Environmental Studies 1995.
4. Holder, S., Bearley, T., Brower, D.J. and. Schwab, A.K., “An Introduction to Coastal Zone Management”, Island Press, 2nd Edition,2002.
5. Le Tissier, M.D.A., S. Coulthard, D. Rath and H.A.Y. Whyte (eds), “Integrated Ocean Technology –From post-graduate to professional Coastal Manager – A Teaching Manual”, www.coastalprofs.eu, 2008.
6. Ramesh, R. and Purvaja, R., “E-learning module on ICZM for UNESCO-IHE”, The Netherlands,2006
7. NCSCM, Strategies and Guidelines for National Implementation of Integrated Coastal Zone Management, 2013.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	2	2	2
CO2		2	2	2	2	2
CO3			3	3	3	2
CO4	2	2	3	3	2	2
CO5	2	2	3	2	3	3
Avg	**2**	**2**	**3**	**2**	**2**	**2**

1- Low, 2 – Medium, 3 – High

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OT3008 SOCIO-ECONOMIC ASPECTS OF COASTAL MANAGEMENT L T P C
3 0 0 3

UNIT I ICZM AND THE SOCIAL SCIENCES 9

Background to ICZM - Sustainability and Sustainable ICZM — Competing Claims and Visions of the Coast - ICZM 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 ICZM

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1 Understand the basic of ICM and the social science
CO2 Identify and classify the stakeholder's participation, stakeholders' social changes and calamites of social changes
CO3 Identify the culture and livelihood of coastal dwellers and their indigenous knowledge in Coastal Management.
CO4 Study property rights, statutory law and customary law
CO5 Illustrate the various governing policies of the coast for ICM

REFERENCES:

1. Lee, Wen Chiat, and K. Kuperan Viswanathan, "Managing Fisheries Conflicts in SoutheastAsia", Journal of Economics and Sustainability (JES) 4, 2022
2. Morales, Juan A, "Mitigation, Coastal Policies and Integrated Coastal Zone Management",In Coastal Geology, pp. 447-455. Springer, Cham, 2022.
3. Tambe, Sandeep, "Sustainable Livelihoods Approach- In Teaching and Learning Rural Livelihoods", pp. 45-56. Springer, Cham, 2022.
4. Brown, Katrina, and Emma Louise Tompkins, "Making waves: integrating coastal conservation and development", Taylor & Francis, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	3
CO2	3	2	3	3	2	2
CO3	3	2	2	2	3	3
CO4	2	1	2	2	3	2
CO5	2	1	2	2	2	2
Avg	**2**	**2**	**2**	**2**	**2**	**2**

1- Low, 2 – Medium, 3 – High

Attested

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OT3009 COASTAL HAZARDS AND MANAGEMENT L T P C
3 0 0 3

UNIT I INTRODUCTION TO HAZARDS 9

Introduction to Environmental and Human induced hazards - Natural vs. Man-made hazard - Hazard and disaster, vulnerability, resilience - coping mechanisms.

UNIT II COASTAL HAZARDS 9

Coastal hazards- Cyclones, Earthquakes, Tsunami, Coastal 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 9

Disaster risk response frameworks - Mapping and planning for disaster management - capacity building - risk transfer mechanisms -Bio shields - 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), coastal erosion, oil spills, chemical disasters, nuclear disasters - vulnerability of coastal megacities.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Highlight the concepts of hazards and their related physical process
CO2 Recall the concepts of natural and manmade hazards.
CO3 Explain the various laws and policies involved in - institutional coordination of India.
CO4 Summarize about the indigenous knowledge practiced in India, mapping and planning of disaster management
CO5 Manage the hazards based on case studies and respond in the event of a disaster by appropriate strategies.

REFERENCES:

1. Bryant, E., “Natural Hazards”, Cambridge University Press, New York, 2010.
2. Rajib Shaw and RR Krishnamurthy, “Disaster Management: Global Challenges Local Solutions”, 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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	3	2	2
CO2	2	2	2	3	2	3
CO3		2	3	3	2	3
CO4	2	2	3	3	3	2
CO5	3	2	3	3	3	3
Avg	**2**	**2**	**3**	**3**	**3**	**2**

1- Low, 2 – Medium, 3 – High

OT3010 DEEP SEA TECHNOLOGY L T P C
3 0 0 3

UNIT I DEEP OCEAN MISSION AND DEEP SEA TECHNOLOGY 9

History and Technology of Deep-Sea Exploration - Deep Ocean Mission (DOM) –Components of DOM - Deep Ocean Survey: bathymetry, seismic and side scan –Deep Sea Mining- Underwater vehicles: Automatic Unmanned Vehicles - Underwater robotics: Manned and Unmanned remotely controlled diving robots.

UNIT II NON-LIVING RESOURCES OF DEEP OCEAN 9

The deep oceans mineral resources - Polymetallic nodules; cobalt rich manganese crust and hydrothermal deposits. Utilizing this mineral wealth for the benefit of mankind will be the focus of ocean mining activities in future. Polymetallic nodules have valuable metals such as Copper, Cobalt, Nickel and Manganese; Gas hydrates; Overview of proposed technologies for utilization of deep-sea resources.

UNIT III DEEP SEA PROBES AND SUBMERSIBLES 9

Deep sea probes – rationale for use of submersibles – manned and unmanned submersibles – advantages and disadvantages. Technological applications, overview of marine terotechnology- Applications in marine geology – Sea Water Intake System – Pipes and Cables – Marine Landslides.

UNIT IV DEEP SEA EXPLORATION VEHICLES 9

Towed vehicles – self-propelled tethered and untethered vehicles – bottom crawlers – deep submergence rescue vessels – ROV – application of submersibles – launching and retrieval processes – survey methods – underwater navigation and application – Marine Landslides

UNIT V DEEP OCEAN BIODIVERSITY 9

Deep ocean biodiversity exploration - Conservation of Deep-Sea Biodiversity - Protection of Coral reef, Turtles and Marine Mammals - Ocean waste disposal sites – certification and safety standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the basic principles of deep-sea technology and modern instruments.

CO2 Learn about the exploration and exploitation of deep ocean mineral resources such as poly-metallic manganese nodules, gas hydrates, hydrothermal sulphides etc.

CO3 Understand the Deep Sea Technologies involved in manned and unmanned underwater vehicles and its application.

CO4 Understand about the application of submersible and survey methods

CO5 Learn on specific underwater exploration technologies for such scenarios in reefs, shelf, pipe laying and marine safety standards.

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REFERENCES:

1. Anthony John Watts, Ward Lock, “A source book of submarines and submersibles”, 1st Edition., 1976.
2. Childs, John, “Geographies of deep-sea mining: A critical review”, The Extractive Industries and Society, 2022.
3. Chris Bell, “Handbook for Rov Pilot-Technicians”, Penn Well Books, 2ndEdition, 1994.
4. Rank Busby, “Manned Submersibles”, U S Navy 1stEdition., 1976.
5. Robert F. Burgess, “Ships Beneath the Sea A History of Subs and Submersibles”, McGraw Hill, 1st Edition., 1975.
6. Peter Beaumont and Constantinos Soutis, “Structural Integrity and Durability of Advanced Composites: Innovative Modelling Methods and Intelligent Design”, Woodhead Publishing, 2015.
7. Deborah Lock, “Submarines and Submersibles”, D K Publishing., 1st Edition, 2007
8. Gerhard Haux, “Subsea Manned Engineering”, Best Pub. Comp., 1st Edition, 1982.
9. Gardner Soule, “Undersea frontiers; exploring by deep-diving submarines”, T and McNally, 1st Edition, 1968.
10. Peter R Limburg, “Vessels for underwater exploration”, Crown Pub, 1st Edition, 1973.
11. Rahul Sharma, “Deep-Sea Mining: Resource Potential, Technical and Environmental Considerations”, Ed, Springer, 2017

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	2	2	2	3	3	2
CO3	3		3	3	2	2
CO4			3	3	2	2
CO5	2		2	3	3	3
Avg	**2**	**2**	**2**	**3**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3011 OCEAN RENEWABLE ENERGY L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Introduction to the ocean environment - Ocean circulation and stratification - Ocean habitat- Ocean economy - Generation of waves – Wave theories – Tidal waves – Energy from oceans – Wind, Tides, Waves, Currents, Geothermal, Salinity and thermal gradients with special reference to Indian coast – Energy converters for extraction of ocean energy – Design principles of wave power, tidal power and OTEC systems –Cost benefit analysis - Site selection and characterization for ocean energy systems

UNIT II OCEAN THERMAL ENERGY CONVERSION 9

Working principle, Resource and site requirements, Location of OTEC system, Electricity generation methods from OTEC, open cycle and closed cycle OTEC systems, Advantages and disadvantages, Applications of OTEC.

UNIT III TIDAL ENERGY 9

Origin and nature of tidal energy, Basic principle of tidal power generation, Components of tidal power plants, Tidal energy technology, Tidal range power, Basic modes of operation of tidal systems. Advantages and limitations.

UNIT IV WAVE ENERGY 9

Wave energy systems - Types of wave energy converters - Linear wave structure interactions – Frequency domain analysis - Hydrodynamic coefficients and their computation - Time domain analysis - Phase control - Arrays - Model testing techniques - Marine current turbines - Types of marine current turbines – Hydrodynamic models (BEM, Lifting line, IBEM) - Hydrofoil data and analysis - Cavitation and strength - Design criteria

UNIT V OCEAN ENERGY SYSTEMS TECHNOLOGIES 9

Offshore wind turbines/ Wind mills - Floating Wind Turbine-Mooring and anchoring systems - Farm layout - Offshore electrical grid and connection systems - Offshore operations and maintenance - Shore based solar panel system - Water turbines - High pressure hydraulic systems - Power generation- Power evacuation - Energy storage -Maritime safety issues

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Define the alternative energy sources from the ocean.
CO2 Explain the principles, requirement, types and components of OTEC.
CO3 Discuss the concept of Tidal Energy
CO4 Describe the various types of Wave Energy, arrays turbines based on design criteria.
CO5 Understand the various types of Ocean Energy Systems Technologies

REFERENCES

1. Pecher, Arthur, and Jens Peter Kofoed, “Handbook of ocean wave energy”, Springer Nature, 2017.
2. Dhanak, Manhar R., and Nikolaos I. Xiros, “Springer handbook of ocean engineering”.Springer, 2016.
3. Ramesh Kumar, “Renewable Energy Technologies”, Narosa Publications 1997 .
4. Tiwari, G.N., and Ghosal, M.K, “Renewable Energy Resources ñ Basic Principles and applications”, Narosa PublishingHouse,2007
5. Yang, Zhaoqing, and Andrea Copping, “Marine renewable energy: Resource characterization and physical effects”, Springer, 2017.
6. Neill, Simon P., and M. Reza Hashemi, “Fundamentals of ocean renewable energy: generating electricity from the sea”,. Academic Press, 2018.
7. Greaves, Deborah, and Gregorio Iglesias, “Wave and tidal energy”, John Wiley & Sons, 2018.
8. Pecher, Arthur, and Jens Peter Kofoed, “Handbook of ocean wave energy”, Springer Nature, 2017.
9. Babarit, Aurélien, “Ocean wave energy conversion: resource, technologies and performance”, Elsevier, 2017.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	3
CO2	2	2	2	3	2	2
CO3	2	2	2	3	3	2
CO4	3	3	2	3	3	3
CO5	3	2	3	3	3	3
Avg	**2**	**2**	**2**	**3**	**3**	**3**

1- Low, 2 – Medium, 3 – High

OT3012 MARINE GEOTECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION TO MARINE GEOTECHNICAL ENGINEERING 10

Scope of marine geotechnical engineering- Marine and submarine soils- Classification of marine soils- Relative distribution of marine soils in the different marine regions- General characteristics of marine deposits in some specific locations and in the Indian subcontinent. Fine and coarse-grained deposits- Strength and deformation behaviour of fine and coarse-grained marine deposits- Effect of cementation- Strength and deformation behaviour under static and cyclic loading

UNIT-II MARINE SOIL INVESTIGATION 7

General characteristics of offshore soil exploration - Sampling using free corer, gravity corer, tethered systems and manned submersibles - Deep penetration sampling using wire line techniques - In-situ determination of strength of submarine soils - Penetrometer, piezocone, vane and pressure meter techniques - General reconnaissance procedure for installation of fixed structures (gravity and piled type), floating structures.

UNIT III FOUNDATIONS FOR JACKET AND JACK-UP PLATFORMS 12

Jacket Platforms-Design considerations- Axial and lateral load capacity of piles - Lateral load deformation behaviour of piles- Calculation of bearing capacity of piles- Design of piles subjected to lateral loads - Reese-Matlock method & p-y curves method.

Jack-up platforms: Piles and mat supported- Spud cans- Stability of jack up platforms- Determination of penetration of supports- Stability under lateral loads- Stability under static and cyclic load effects.

UNIT IV FOUNDATION FOR GRAVITY PLATFORMS 7

Foundations for Gravity Structures: Movement of gravity structures - Settlement of soil beneath gravity structures - Stress distribution beneath gravity structures - Stability of gravity structures under static and cyclic loads.-Overview about design software.

UNIT V SEA BED ANCHORS, MOORINGS AND SUBMARINE PIPELINES 9

General introduction to sea bed anchors, moorings, submarine pipe line etc.-General design considerations (brief outline only)- geotechnical aspects in the design and installation of sea bed anchors, moorings, submarine pipelines etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1. Explain the relevance of marine geotechnical engineering and their properties
CO2. Know the different methods/techniques adopted for offshore soil investigations
CO3. Analyse and design the foundations for the Jacket and Jack-up structures
CO4. Analyse and design the foundations for the gravity structures
CO5. Provide an overall picture of foundations for supplementary offshore facilities**.**

REFERENCES:

1. Chaney, F. Marine Geotechnology and nearshore/offshore structures, ASTM, STP-, 1986.
2. Chaney, R. C and Demars, K. R., Strength Testing of Marine Sediments - Laboratory and In-situ Measurements, ASTM, STP -883, 1985.
3. Poulos, H. G and Davis, E. H., Pile Foundation Analysis and Design, John Wiley, 1980.
4. Numerical Methods in offshore Piling, Proc. Conf. Inst. of Civil Engineers, London, 1980.
5. Le Tirant, Sea Bed Reconnaissance and Offshore Soil Mechanics for the Installation of Petroleum Structures, Gulf Publ. Co., 1979.
6. George, P and Wood, D, Offshore Soil Mechanics, Cambridge University Press, 1976.

REFERENCES:

1. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, Cengage Learning, India Edition, New Delhi, 2010.
2. Gupta S.K., “Numerical Methods for Engineers”, New Age Publishers, 3rd Edition, NewDelhi, 2015.
3. Jain M. K., Iyengar S. R. K., Jain R.K., “Computational Methods for Partial DifferentialEquations”, New Age Publishers, 2nd Edition, New Delhi, 2016.
4. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”,Cambridge University press, Cambridge, 2005.
5. Sastry S.S., "Introductory Methods of Numerical Analysis", Prentice - Hall of India Pvt.Limited, 5th Edition, New Delhi, 2012.
6. Saumyen Guha and Rajesh Srivastava, “Numerical methods for Engineering and Science”, Oxford Higher Education, New Delhi, 2010.

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CO-PO MAPPING

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CO1	3	3	3	3	2	2
CO2	2	3	3	2	2	2
CO3	2	3	3	3	2	2
CO4	2	2	2	2	2	2
CO5	1	1	1	2	2	2
Avg	**2**	**2**	**2**	**3**	**2**	**2**

1- Low, 2 – Medium, 3 – High

OT3013 SUSTAINABLE BLUE ECONOMY L T P C
3 0 0 3

UNIT I BLUE ECONOMY 11

Introduction : Blue Economy – History of Blue Economy - The Blue Economy and its Opportunities - Concept of circular economy and its connectivity with sustainability – The Blue economy framework for sustainable development - Development of Blue Economy in India and other countries - Legal Regime for Exploration and Exploitation of Marine Resources - Review of Business opportunities and Constraints in India -India's Draft Policy Framework: India's Vision of New India by 2030

UNIT II FISHERIES AND AQUACULTURE 11

Artisanal fisheries – practices and their role in energy efficient fleets and passive gears - its benefits – Industrial fishing – boats/trawlers used – type of fishing nets used – methods to control overfishing – sustainable industrial fishing practices - Aquaculture – potential of capture fisheries (pond/cage culture etc.) – Processing and export industries - need to minimize the ecological impact – Revenue generated from fisheries and aquaculture and its dependent industries.

UNIT III MARINE AND COASTAL TOURISM 9

Tourism and its diversification benefits in blue economy – types of tourism practiced along Indian coast – Tourism and its dependent industries - opportunities for new and sustainable form of tourism – Need for ecofriendly tourism.

UNIT IV OCEAN ENERGY AND SUBMARINE MINING 7

Offshore wind power – Wave energy – Ocean Thermal energy conversion (OTEC) – Tidal energy – Marine current – Submarine mining : Polymetallic nodules – Gas Hydrates - cobalt crusts and massive sulphide deposits - its benefits to sustainable blue economy

UNIT V SHIPPING AND PORT FACILITIES 7

Policy of Sustainable Blue Economy in Shipping and Port Facilities - Development and Expanding of Port facilities – Maritime Transport and International trade - India's Foreign Trade.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1 Relate the concept of Blue economy and its framework for sustainable development.
CO2 Summarize the various fisheries and aquaculture techniques
CO3 Understand the sustainable practices in tourism
CO4 Acquire knowledge on ocean renewable energy sustainable use of ocean resources for livelihoods and economic growth.
CO5 Understand the Blue Economy Policies for Shipping and Port facilities.

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REFERENCES

1. National Maritime Foundation (New Delhi, India). Annual maritime power conference. (2017). The blue economy: concept, constituents and development. Pentagon Press.
2. Islam, M. N., & Bartell, S. M. (Eds.). (2022). Global Blue Economy: Analysis, Developments, and Challenges. CRC Press.
3. Pauli, G. (2015). Blue economy 2.0: 200 progetti implementati, 4 miliardi di dollari investiti, 3 milioni di nuovi posti di lavoro creati. Edizione Ambiente.
4. Mukhopadhyay, R., Loveson, V. J., Iyer, S. D., & Sudarsan, P. K. (2020). Blue economy of the Indian Ocean: resource economics, strategic vision, and ethical governance. CRC Press.
5. Brears, R. C. (2021). Developing the Blue economy. Palgrave Macmillan.
6. India's Blue Economy: A draft Policy framework – incois report

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	3
CO2	2	2	2	3	2	3
CO3	2	2	2	2	2	3
CO4	3	3	3	3	3	3
CO5	2	3	3	2	3	3
Avg	**2**	**3**	**2**	**2**	**2**	**3**

1- Low, 2 – Medium, 3 – High