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 of Civil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.

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UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.TECH.OCEAN TECHNOLOGY

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the Programme M. Tech. Ocean Technology will

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

2. PROGRAMME OUTCOMES (POs):

After going through the four years of study, our Remote Sensing and Geomatics 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	An ability to apply various advanced tools and techniques to develop efficient Hardware solutions
PO5	Design/development of solutions	Design a system or a component to meet the design requirements with constraints exclusively.
PO6	Environment and sustainability	Design the System with environment consciousness and sustainable development.

Attested

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MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES:

A broad relation between the programme objective and the outcomes is given in the following table:

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	1	3	2
IV	3	2	3	2	3	1
V	2	2	2	1	2	2
Correlation Level : 3 – High, 2 – Medium, 1 - Low						

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MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

M.TECH. OCEAN TECHNOLOGY

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Advanced Numerical Methods						
		Oceanography	3	3	1	1	1	3
		Wave Hydrodynamics	3	2	2	3	2	2
		Marine and Coastal Resources Management	3	3	2	2	3	3
		Program Elective I						
		Research Methodology and IPR						
		Audit course I						
		Marine Water Quality and Sediment Laboratory	3	2	2	2	2	2
	SEMESTER II	Coastal Engineering	3	3	3	3	3	2
		Satellite Oceanography and GIS	3	2	2	2	2	2
		Sea Surveying and Instrumentation	2	2	3	3	2	2
		Offshore Technology	2	3	2	3	2	2
		Program Elective II						
		Program Elective III						
		Audit course II						
		Remote Sensing and GIS Laboratory	3	2	3	2		2
		Coastal Hydrodynamic Modelling Laboratory	3	2	2	2		2
YEAR II	SEMESTER III	Deep Sea Technology	2	2	2	3	2	2
		Port and Harbor Engineering	2	2	3	2	2	3
		Program Elective IV						
		Open Elective I						
		Practical Training (2 weeks)	3	3	3	3	3	3
		Project Phase I	3	3	3	3	3	3
	SEMESTER IV	Project Phase II	3	3	3	3	3	3

Correlation Level : 3 – High, 2 – Medium, 1 - Low

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MAPPING OF PROFESSIONAL ELECTIVE COURSES [PEC]

Course Name	PO1	PO2	PO3	PO4	PO5	PO6
Marine Pollution Monitoring and Management	3	2	1	2	2	1
Fisheries and Aquaculture Technology	3	2	2	2	2	2
Modeling of Coastal Processes	3	2	2	3	2	2
EIA and Ocean Governance	2	3	3	2	2	3
Ocean Renewable Energy	2	2	2	3	3	3
Coastal Hazards and Management	2	2	3	3	2	2
Integrated Coastal Zone Management	2	2	3	3	3	2
Coastal Ecosystem and Biodiversity	2	2	2			3
Global Climate Change and Oceans	2	3	2	2	2	2
Marine Toxicology	2	2	2		1	2
Socio-economic aspects of Coastal Management	2	2	2	1		2

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UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.TECH. OCEAN TECHNOLOGY
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.	MA5154	Advanced Numerical Methods	FC	3	1	0	4	4
2.	OT5101	Oceanography	PCC	3	0	0	3	3
3.	OT5102	Wave Hydrodynamics	PCC	3	0	0	3	3
4.	OT5103	Marine and Coastal Resources Management	PCC	3	0	0	3	3
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Program Elective I	PEC	3	0	0	3	3
7.		Audit course I*	AC	2	0	0	2	0
PRACTICALS								
8.	OT5111	Marine Water Quality and Sediment Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**4**	**24**	**20**

*** Audit Course is optional**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	OT5201	Coastal Engineering	PCC	3	0	0	3	3
2.	OT5202	Satellite Oceanography and GIS	PCC	3	0	0	3	3
3.	OT5203	Sea Surveying and Instrumentation	PCC	3	0	0	3	3
4.	OT5204	Offshore Technology	PCC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.		Program Elective III	PEC	3	0	0	3	3
7.		Audit course II*	AC	2	0	0	2	0
PRACTICALS								
8.	OT5211	Remote Sensing and GIS Laboratory	PCC	0	0	4	4	2
9.	OT5212	Coastal Hydrodynamic Modelling Laboratory	PCC	0	0	2	2	1
			TOTAL	**20**	**0**	**6**	**26**	**21**

*** Audit Course is optional**

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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.	OT5301	Deep Sea Technology	PCC	3	0	0	3	3
2.	OT5302	Port and Harbour Engineering	PCC	3	0	0	3	3
3.		Program Elective IV	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	OT5311	Practical Training (4 weeks)	EEC	0	0	0	0	2
6.	OT5312	Project Phase I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**20**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	OT5411	Project Phase II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL: 73 CREDITS

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA5154	Advanced Numerical Methods	3	1	0	4	1

PROGRAM CORE COURSES (PCC)

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OT5101	Oceanography	3	0	0	3	1
2.	OT5102	Wave Hydrodynamics	3	0	0	3	1
3.	OT5103	Marine and Coastal Resources Management	3	0	0	3	1
4.	OT5111	Marine Water Quality and Sediment Laboratory	0	0	4	2	1
5.	OT5201	Coastal Engineering	3	0	0	3	2
6.	OT5202	Satellite Oceanography and GIS	3	0	0	3	2
7.	OT5203	Sea Surveying and Instrumentation	3	0	0	3	2
8.	OT5204	Offshore Technology	3	0	0	3	2
9.	OT5211	Remote Sensing and GIS Laboratory	0	0	4	2	2
10.	OT5212	Coastal Hydrodynamic Modelling Laboratory	0	0	2	1	2
11.	OT5301	Deep Sea Technology	3	0	0	3	3
12.	OT5302	Port and Harbour Engineering	3	0	0	3	3
					Total Credits	**32**	

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PROGRAM ELECTIVE COURSES [PEC]

S. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OT5001	Marine Pollution Monitoring and Management	3	0	0	3
2.	OT5002	Fisheries and Aquaculture Technology	3	0	0	3
3.	OT5003	Modeling of Coastal Processes	3	0	0	3
4.	OT5004	EIA and Ocean Governance	3	0	0	3
5.	OT5005	Ocean Renewable Energy	3	0	0	3
6.	OT5006	Coastal Hazards and Management	3	0	0	3
7.	OT5007	Integrated Coastal Zone Management	3	0	0	3
8.	OT5008	Coastal Ecosystem and Biodiversity	3	0	0	3
9.	OT5009	Global Climate Change and Oceans	3	0	0	3
10.	OT5010	Marine Toxicology	3	0	0	3
11.	OT5011	Socio-economic aspects of Coastal Management	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

Sl. No	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	RM5151	Research Methodology and IPR	2	0	0	2	1
					Total Credits:	**2**	

OPEN ELECTIVE COURSES [OEC]

*(Out of 6 Courses one Course must be selected)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

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AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
					TOTAL CREDITS	**0**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	OT5311	Practical Training	0	0	0	2	2
2	OT5312	Project Phase I	0	0	12	6	3
3	OT5411	Project Phase II	0	0	24	12	4
					Total Credits:	**20**	

TOTAL : 73 CREDITS

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	11	14	06	00	32
3.	PEC	03	07	03	00	12
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	00	08	12	20
7.	Non Credit/Audit Course	✓	✓	00	00	
	TOTAL CREDIT	**22**	**21**	**16**	**12**	**73**

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MA5154 **ADVANCED NUMERICAL METHODS** **L T P C**
3 1 0 4

OBJECTIVES:

- To impart knowledge in understanding the advantages of various solution procedures ofsolving the system of linear and nonlinear equations.
- To give a clear picture about the solution methods for solving the BVPs and the system of IVPs.
- To acquire knowledge in solving time dependent one and two dimensional parabolic PDEs by using various methodologies.
- To strengthen the knowledge of finite difference methods for solving elliptic equations.
- To get exposed to the ideas of solving PDEs by finite element method.

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, Eigen value 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

OUTCOMES:

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

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

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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.

OT5101 OCEANOGRAPHY L T P C

3 0 0 3

OBJECTIVES:

- To introduce the students the basic concepts involved in oceanography
- To understand the physical, Chemical, geological and biological processes involved in oceans
- To provide the background needed to undertake oceanographic investigations and sets them in context by incorporating case studies and sample problems based on local and global examples.

UNIT I PHYSICAL CEANOGRAPHY 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 II CHEMICAL OCEANOGRAPHY 9

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

UNIT III BIOLOGICAL OCEANOGRAPHY 9

The Marine realm - Phytoplankton diversity, diurnal vertical migration - Photosynthesis and primary productivity and seasonality - Eutrophication and Harmful algal blooms (HABs) - Zooplankton and Secondary production - Respiration - Nekton –Food Chain – Food Web – Bio Geo Chemical Cycle- Marine microbes and microbial Loop - Limiting nutrients in seawater

UNIT IV GEOLOGICAL OCEANOGRAPHY 9

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

UNIT V ENVIRONMENTAL OCEANOGRAPHY 9

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

Attested

TOTAL: 45 PERIODS

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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 Analyze the overall impact of the human activities on the sea, considering the DPSIR framework based on case studies.

REFERENCES:

1. Garrison, Tom S, "Oceanography: an invitation to marine science", Cengage Learning, 2015.
2. Emerson, Steven R., and Roberta C. Hamme. "Chemical Oceanography", Cambridge University 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 –OCEANOGRAPHY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		1	2		2
CO2	3	2	1	2	2	1
CO3	3	2	2	2	1	3
CO4	3	2	2	1	1	2
CO5	3	2	1	1	1	3
Overall Correlation of COs and POs	3	2	1	1	1	3

OT5102 **WAVE HYDRODYNAMICS** **L T P C**
3 0 0 3

OBJECTIVE:

- To make the students be aware of ocean wave classification, the mass, momentum and wave energy transformations and wave kinematics that are happening in nature and enable them in the prediction and analysis of the wave data.

UNIT I CONSERVATION OF MASS, MOMENTUM AND ENERGY 9

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

UNIT III WAVE KINEMATICS 9

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

UNIT IV WAVE THEORIES 9

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

UNIT I V WAVE ANALYSIS AND WAVE PREDICTION 9

Short term wave analysis- Short term wave Height Distribution – Wave period Distribution - Time and Frequency domain Analysis of Wave Records - wave energy spectra –Long term wave analysis – Gumbel Distribution – Weibull Distribution - Statistics analysis of grouped wave data.

TOTAL: 45 PERIODS

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 and wave loads along with its properties.

CO4 Classify the various nonlinear wave theories including the Stokes second order theory, solitary and cnoidal 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.

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CO – PO MAPPING - WAVE HYDRODYNAMICS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	2	3	1	
CO2	3	3	2	3	1	
CO3	3	2	2	3	2	
CO4	3	2		3	3	
CO5	2		3	3	2	2
Overall Correlation of COs and POs	3	2	2	3	2	2

OT5103 MARINE AND COASTAL RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

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

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 - 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

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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.

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 – MARINE AND COASTAL RESOURCES MANAGEMENT

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2				2
CO2	3	3			2	3
CO3	3	3	2	3	3	3
CO4	3		2	2	3	3
CO5	2	3	2			2
Overall Correlation of COs and POs	3	3	2	2	3	3

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of researchproblem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW **6**

Effective literature studies approaches, analysis, plagiarism, and research ethics

UNIT III TECHNICALWRITING /PRESENTATION **6**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, InformationTechnology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

OT5111 MARINE WATER AND SEDIMENT QUALITY LABORATORY **L T P C**
0 0 4 2

OBJECTIVES:

- To analyze the physical and chemical parameters of marine water and sediment
- To build an understanding on the various computing techniques available for marine and coastal pollutants

1	Introduction to NABL, Demo of water quality field kit, Field measurements, Water sample collection and transport, introduction to analytical laboratory, Good Laboratory Practices and Quality Control.	4
2	Determination of Physical parameters of Marine water sample pH, Salinity, EC, Turbidity, TDS, TSS) and Marine sediment sample Soil Texture (Sand, Silt, Clay)	12
3	Determination of Chemical parameters of Marine water sample Ammonia, Nitrate, Total Nitrogen, Inorganic Phosphate, Total Phosphate, Silicate)	12
4	Determination of Microplastics in the Marine water & Marine Sediment sample.	12
5	Determination of Heavy metals in the Marine water & Marine Sediment sample. (Copper, Mercury, Arsenic, Lead, Zinc, Cadium etc.)	20

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1 Summarize the basic sampling and techniques involved in Marine water and Marine sediment sample.

CO2 Examine the physical parameter in the Marine water quality and Sediment based on the standards.

CO3 Experiment the chemical elements presents in Marine water sample.

CO4 Evaluate the Microplastic concentration in the sea water and sediment samples.

CO5 Assess the Heavy metals concentration in the sea water and sediment samples.

CO – PO MAPPING – MARINE WATER QUALITY AND SEDIMENT LABORATORY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1				2		
CO2	3	2	2	2	2	2
CO3	3	2	1	2	2	2
CO4	3	2	2	2	2	2
CO5	3	2	2	2	2	2
Overall Correlation of COs and POs	3	2	2	2	2	2

REFERENCES

1. J.D. Strickland and T.R. Parsons, " A Practical Handbook of Seawater Analysis", Bull. Fish. Res. Bd, 1972
2. Yuncong Li, Kati Migliaccio, "Water Quality Concepts, Sampling, and Analyses", Taylor & Francis, 2010
3. 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.
4. Hrissi K. Karapanagioti; Ioannis K. Kalavrouziotis, " Microplastics in Water and Wastewater", IWA Publishing Company, 2019

OT5201 COASTAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To provide students with an introduction to coastal engineering with strong focus on wave behavior and sediment dynamics
- To diverse them in topics like coastal structures, shore protection methods and its techniques using case studies

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 – Behavior 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.

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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 – Longshore 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 harbor 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 centers 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 armor – 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 defense structures; Hard Engineering measures- Sea walls, Revetments, Bulkheads, Dikes, Groynes, Breakwaters; Soft Engineering measures – Artificial Reefs, Beach nourishment, Dune regeneration, Salt marsh Creation - Bioshields - Case studies - Latest technologies in shore protection techniques.

TOTAL: 45 PERIODS

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.

CO – PO MAPPING - COASTAL ENGINEERING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	
CO2	3	3	3	3		2
CO3	3	3	3	3		
CO4	3	2	2	3	3	3
CO5	3	3	3	2	3	2
Overall Correlation of COs and POs	3	3	3	3	3	2

OT5202 **SATELLITE OCEANOGRAPHY AND GIS** **L T P C**
3 0 0 3

OBJECTIVES:

- To describe the basic principles of remote sensing including: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems will be taught.
- To provide the GIS platforms in oceanographic applications of satellite remote sensing in coastal environments

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 GEOGRAPHIC INFORMATION SYSTEM **9**

Definition – Basic components of GIS – Map projections and co-ordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology – Geodatabase models: hierarchical, network, relational, object-oriented models – Overlay Analysis, Spatial interpolation, Digital Elevation Model.

UNIT IV OCEANOGRAPHIC APPLICATION **9**

Ocean Color Mapping – Sea Surface Temperature – Sea Surface Topography - Chlorophyll – Carbon Sequestration - Potential Fish Zoning – Oil Spill Monitoring – Ship Navigation – Case Studies.

UNIT V MARINE AND COASTAL APPLICATIONS **9**

Marine Spatial Planning - Methodologies for Defining Habitats - Mapping Coral Reefs, Macroalgae, Mangrove and Wetlands - Coastal Landuse/Land Cover Mapping - Coastal Geology and Geomorphology – Shoreline Changes – CRZ Mapping – Coastal Hazard and Vulnerability Mapping – Case Studies.

TOTAL : 45 PERIODS

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 Illustrate the basic components in Geographical Information System and understand the different data structures.
CO4 Summarize to use oceanographic applications of satellite remote sensing
CO5 Apply the concept of remote sensing in marine and coastal environment

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 - SATELLITE OCEANOGRAPHY AND GIS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	1	1		1
CO2	3	2	2	2	2	
CO3	3	2	2	2		2
CO4	3	2	3	2	2	
CO5	3	2	3	2	3	3
Overall Correlation of COs and POs	3	2	2	2	2	2

OT5203 SEA SURVEYING AND INSTRUMENTATION L T P C
3 0 0 3

OBJECTIVES:

- To introduce the students to the basic terms and techniques involved in sea-surveying
- To study marine geo physical survey, tidal, current and other parameter measurements along with its associated instrumentation

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 - Feature detection 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 to a 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, operation and applications**.** Harmonic Analysis and Tide Prediction - Principles of Tidal Currents - Measurements and Prediction of Currents and wave measurements.

TOTAL :45 PERIODS

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.
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 – SEA SURVEYING AND INSTRUMENTATION

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		1	3		
CO2	2	2	2	3	2	2
CO3	2	2	3	3		
CO4	3	2	3	3		
CO5	3	3	3	3	2	2
Overall Correlation of COs and POs	2	2	3	3	2	2

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OT5204 **OFFSHORE TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To make the students to understand the basic principles of Offshore Technology and Offshore structures.
- To provide an overview of site exploration of marine sediments and sampling techniques.
- To learn about the concepts of oil and gas exploration, Study, control, and prevention of the industry's impact on the marine environment and its living resources.
- To learn about the concepts of fixed offshore platform design factors
- To learn about ultimate strength, fatigue, and design principles of offshore floating systems.

UNIT I MARINE SEDIMENTS AND SAMPLING TECHNIQUES 9

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 pile supported and gravity offshore structures.

UNIT II OFFSHORE STRUCTURES 9

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 – Minimum facility – Subsea Templates – Subsea Pipelines – Complaint Structures – Articulated Platforms – Complaint Tower – Guyed Tower

UNIT III FIXED OFFSHORE PLATFORM 9

Field Development and Concept Selection – Introduction –Field Development Design Phase– Basic and Detailed Design of a Fixed jacket- Platforms–Jacket Structures – Gravity Base Structures – Jack-ups - Fabrication – Transportation & Installation of fixed offshore jacket structures - Underwater Inspection & repair of fixed platforms - Life cycle management & decommissioning of offshore facilities.

UNIT IV FLOATING OFFSHORE PLATFORM DESIGN FACTORS 9

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

UNIT V OFFSHORE OIL AND GAS OPERATIONS 9

Offshore oil and gas exploration - Geology – Geophysical Survey, Exploration & Production of Oil & Gas - Enhanced recovery methods, Subsea Pipelines Installation & maintenance

TOTAL:45 PERIODS

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 Explain the concepts of oil and gas exploration and to study about the Subsea Pipelines Installation & maintenance
CO4 Learn about the concepts of fixed off shore platform design factors
CO5 Enumerate the design principles of offshore floating systems.

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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 –OFFSHORE TECHNOLOGY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2		1
CO2	2	3	3	2	2	
CO3	3	3	3	3	3	3
CO4		2	2	3	2	2
CO5	3	3	2	3	3	2
Overall Correlation of COs and POs	2	3	2	3	2	2

OT5211 REMOTE SENSING AND GIS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To give practical exposure to the students to data input, data storage, data analyses and data output capabilities of a standard GIS software (proprietary and open software’s)
- To enhance the skills in mapping techniques and prepare students for geospatial workforce

EXERCISES:

1. Satellite data products: commercial and open source
2. Land use Land cover Classification- Unsupervised and supervised.
3. Data Conversion – Vector to Raster, raster to Vector
4. Georeferencing of toposheet and creating vector layers
5. Geodatabase creation and Digitization of point, line and Polygon features
6. Creation of attribute tables and layout preparation
7. Transformation of Data from Google earth to GIS Environment & Excel sheet to GIS Environment
8. File conversion from .kml to .shp.
9. DEM analysis using ArcGIS
10. Analysis of spatial information- clip – buffer
11. Overlay Analysis using ArcGIS
12. Interpolation of Point data to create Spatial Maps
13. Mapping of Sea Surface Temperature
14. Mapping of Shoreline changes
15. Coastal Land Use/Landcover mapping

Attested

TOTAL: 60 PERIODS

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OUTCOMES:

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

CO1 Gain knowledge about reception, product generation, storage and ordering of satellite data
CO2 Understand the concept of different image processing techniques and interpretation of satellite data
CO3 Create GIS data base through Digitization and Georeferencing
CO4 Perform Spatial Analysis of Data using GIS tools
CO5 Apply the Remote sensing and GIS tool in Coastal environment

REFERENCES:

1. Lilles and T.M., and Kiefer, R.W, "Remote Sensing and Image interpretation", John Wiley & Sons, 6th edition, 2015.
2. John R. Jensen, "Introductory Digital Image Processing: A Remote Sensing Perspective", Pearson Publications 4th Edition, 2015.
3. John A.Richards, "Remote Sensing Digital Image Analysis", Springer 5th edition, 2013.
4. Paul Longley, "Geographical Information systems and Science", John Wiley & Sons, 4th Edition, 2015
5. Bartelme, Norbert, "Geographic information systems", In Springer handbook of geographic information, pp. 121-149. Springer, Cham, 2022.
6. Kang Tsung Chang, "Introduction to Geographic Information Systems", Tata McGraw Hill Publishing Company Ltd, 9th Edition, 2018.
7. C.P.Lo& Albert. K, "Concepts and Techniques of Geographic Information Systems", Prentice hall of India, 2016.

CO – PO MAPPING -REMOTE SENSING AND GIS LABORATORY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2		2
CO2	3	2	3	2		2
CO3	3	2	3	2		2
CO4	3	2	3	2		2
CO5	3	2	3	2		2
Overall Correlation of COs and POs	3	2	3	2		2

OT5212 COASTAL HYDRODYNAMIC MODELLING LABORATORY **L T P C**
0 0 2 1

OBJECTIVES:

- To give practical exposure to hydrodynamic modelling to the students about Model setup, data input, model calibration, validation and simulation.

1. Overview of marine hydrodynamic Model
2. Creating computational mesh
3. Creating mdf-file from raw xyz data
4. Adjusting boundary data into a domain and triangulation of the domain
5. Variety of Hydrographic Boundary Conditions
6. Hydrodynamic Setup

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7. Creating the bathymetry
8. Creating the Input parameters: Wave condition, Wind conditions, Current Condition
9. Model Setup – Flow Model – Model Calibration – Model extraction
10. Compare model results and measured values.

TOTAL : 30 PERIODS

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 and describe the basics of hydrodynamic modelling.
CO4 Able to understand the fundamental of flow modelling.
CO5 Compare model results and measured values.

REFERENCES:

1. Chapra, S.C. and Canale, R.P, "Numerical Methods for Engineers", Tata McGraw Hill Publishing Co. Ltd. 7thEdition, 2006.
2. Smith, G.D, "Numerical solution of Partial Differential equations", Clarendon Press 3rd Edition,1985.
3. Chapra, S.C, "Surface Water Quality Modeling", McGraw Hill Companies, Inc.1997.
4. Reeves, D., Chadwick, A. and Fleming, C, "Coastal Engineering", Spon Press, 2004.
5. Dean, R.G. and Dalrymple, R.A, "Water wave mechanics for Engineers and Scientists", Prentice-Hall, Inc., Englewood Cliffs, New Jersey,1994.
6. Ippen, A.T, "Estuary and Coastline Hydrodynamics", McGraw-Hill Book Company, Inc. New York,1978.

CO – PO MAPPING – COASTAL HYDRODYNAMIC MODELLING LABORATORY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3		2
CO2	2	2	2	2		2
CO3	3	2	2	1		2
CO4	3	2	2	2		2
CO5	2	2	3	3		
Overall Correlation of COs and POs	3	2	2	2		2

OT5301 **DEEP SEA TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVE:

- To explain the basic principles of deep-sea technology and modern instruments of deep sea resource explorations.
- To learn the various non-living resources and deep ocean biodiversity exploration and strategies for sustainable management of coastal and marine resources.

UNIT I DEEP SEA TECHNOLOGY AND MISSION 9

History and Technology of Deep-Sea Exploration - 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 – Deep Ocean Mission (DOM) – Components of DOM

UNIT II DEEP OCEAN NON-LIVING RESOURCES 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, Mangroves, Turtles and Marine Mammals - Ocean waste disposal sites – certification and safety standards.

TOTAL: 45 PERIODS

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.

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, 2nd Edition, 1994.
4. Rank Busby, “Manned Submersibles”, U S Navy 1st Edition., 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.

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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 DEEP SEA TECHNOLOGY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3		2
CO2	2	2	2	3		2
CO3	3		3	3	2	2
CO4			3	3	2	2
CO5	2		2	3		3
Overall Correlation of COs and POs	2	2	2	3	2	2

OT5302 PORT AND HARBOUR ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES

To make the students understand the basic principles of design of port and harbour structures.

- Explain the significance of ports and harbours as a mode of transport.
- Demonstrate the fundamental principles of wave hydrodynamics and port cargo handling.
- Understanding the Maintenance of waterways, Port and harbor layout for safe and efficient vessels and Dredging for navigation improvement, pipelines and cables, soil replacement.
- Analysis the basic design of port layout and its issues
- Explain the construction, maintenance and renovation aspects of ports and sustainable development strategies for cities and ports

UNIT I INTRODUCTION AND PORT DESIGN 9

Introduction: Planning and Development of port and habours, Types and classification of ports and harbours in India, Natural ports and manmade ports, major ports, minor ports, Port designs and layouts - Design of port infrastructures with regards to cargo handling , cargo storage and integrated transport of goods - planning multipurpose port terminals - Development of new ports and expansion of existing ports and harbours by SAGARMALA.

UNIT II DESIGN OF HARBOUR AND DESIGN ISSUES 9

Design of harbour Infrastructures -Breakwaters, jetties and quay walls - design of break water - shore attached and offshore breakwaters design - design of harbor basin, approach channel, and turning basin, harbours and passenger terminals. Fisheries harbours: Passenger terminals and Cargo terminals - Design issues: Sea port and harbour layout with regards to wave action, hydrodynamic conditions, siltation, navigability and berthing facilities.

UNIT III WATERWAYS OF PORT AND HARBOUR 9

Maintenance of waterways, Port and harbor layout - Safe and efficient vessels navigation, cargo loading and unloading- Navigation channels and dredging - Shore infrastructure and utilities - Land reclamation - Environmental and economic considerations -Capital and annual Dredging - Dredging

equipment - Dredging for navigation improvement, pipelines and cables, soil replacement. Potential effects of dumping of dredged materials on oceanic environment, environmental laws and factors.

UNIT IV 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 - Forecasting /nowcasting / hind casting of wave and current conditions for port operations - Capital and annual dredging and navigability - hazard scenarios - Management of computerized container terminal - Safety: handling of fire, oil spill, rescue, etc., -Annual port operation.

UNIT V SUSTAINABILITY AND CLIMATE CHANGE 9

Introduction, development of green ports and harbours, Planning and construction, expansion of existing port and harbours and renovation of port and Inland Port Infrastructure by sustainable approach. Global trade and port restructuring/reforms along with sustainability, Numerical Modeling studies for impact of possible climate change scenarios against waves, tides, currents and sea level rise, coastal structures, sustainable development strategies for coastal cities and ports.

TOTAL: 45 PERIODS

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 and Dredging 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”, 1st Edition, 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 structural aspects”, 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 – PORT AND HARBOR ENGINEERING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2		2		3
CO2	2		3	3	3	
CO3	2	2	3	3	2	2
CO4	3		3	2	2	
CO5		3	2	2		3
Overall Correlation of COs and POs	2	2	3	2	2	3

OT5311 **PRACTICAL TRAINING (4 Weeks)** **L T P C**
0 0 0 2

OBJECTIVES:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Coastal Management in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

SYLLABUS:

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

OUTCOME:

- They are trained in tackling a practical field/industry orientated problem related to Coastal Engineering.

OT5312 **PROJECT PHASE I** **L T P C**
0 0 12 6

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

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

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

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OT5411 **PROJECT PHASE II** **L T P C**
0 0 24 12

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology. 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

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

OT5001 **MARINE POLLUTION MONITORING AND MANAGEMENT** **L T P C**
3 0 0 3

Objective:

- To educate the students about the marine pollution sources and its impacts to environment
- To identify the effects of marine pollution and methods for monitoring, and control of it.

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.

UNIT II POLLUTANT IN MARINE ENVIRONMENT **9**

Plastics in the marine environment - The “garbage patch,” - Plastic in the marine environment - Prediction of Marine Debris Drifting - Impacts of Marine Debris on Marine Life - Impacts of marine litter on human- Trace metals as pollutants - Factors influencing the toxicity of trace metals to marine organisms - Important contaminant metals in marine systems - Mercury, Cadmium, etc.

UNIT III MARINE POLLUTION EFFECTS AND MEASURES **9**

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

UNIT IV MARINE POLLUTION MONITORING **9**

Methods for the assessment of coastal and marine pollution – Biological productivity and pollution monitoring – Water quality parameters: physical/ chemical/ biological properties, sampling techniques and problems – Nutrients, sewage and anoxia –Impacts of heavy metals – Pathways of radioactivity – 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**

Pollution abatement programs in developed countries – case studies. Assessing pollution damage. Law pertaining to marine pollution– Biodegradation and bioremediation.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Understand the source of marine pollution
CO2 Define the impact on pollutant in Marine Environment.
CO3 Illustrate the effects of marine pollution and adopt proper measures.
CO4 Describe techniques and practices for the monitoring of pollution in the coastal marine environment
CO5 Acquire knowledge on abatements pertaining to marine pollutions.

REFERENCES:

1. Ricardo Beiras, “Marine Pollution sources, fate and effects of pollutants”, Elsevier science, 2018
2. Houma Bachari Fouzia, “Monitoring of Marine Pollution”, IntechOpen, 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.

CO – PO MAPPING – MARINE POLLUTION AND MONITORING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		1		2		
CO2	2	2	1		2	
CO3	3	2	2	3	2	1
CO4	3	2	1	2		2
CO5	1	2		2		1
Overall Correlation of COs and POs	3	2	1	2	2	1

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OT5002 FISHERIES AND AQUACULTURE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To introduce the various fisheries and aquaculture systems and technology development including the basics of fishery, fishing gear and craft technology, economics in fishery and its management
- To describe history of aquaculture, general principles, infrastructural facilities, selection of suitable culturable species, and technologies involved in it.

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 of Fisheries 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

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 Mc Graw 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.

CO – PO MAPPING : FISHERIES AND AQUACULTURE TECHNOLOGY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	1	1	2	2
CO2		2	1	2		2
CO3	3	2	2	2		2
CO4	3	2		2	2	2
CO5	3	2	2	3	3	2
Overall Correlation of COs and POs	3	2	2	2	2	2

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OT5003 **MODELLING OF COASTAL PROCESSES** **L T P C**
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION **6**

Types of models – physical and mathematical models - Modeling of coastal processes - Model development and validation - Basic numerical tools used in mathematical models. Equations governing processes in coastal environment - Case studies of numerical solutions of equations governing coastal processes.

UNIT II HYDRODYNAMIC AND SEDIMENT MODELLING **12**

Basic principles of marine hydrodynamics - Variety of Hydrographic Boundary Conditions, Bed Resistance and Wind Forcing, Wave Theories- 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- Process based modelling of bed load and suspended load - Sediment transport.

UNIT III WATER QUALITY AND ECOLOGY MODELLING **9**

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

UNITIV TSUNAMI MODELLING **9**

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

UNITV STORM SURGE MODELLING **9**

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

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 waves and sediment.

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

CO4 Investigate Tsunami Modelling and interpret using seismic records.

CO5 Evaluate Storm surge modelling based on meteorological factors like bathymetry, wind speed, 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. New York,1978.

CO – PO MAPPING –MODELING OF COASTALPROCESSES

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3		2
CO2	3	2	2	3		2
CO3	2	2	2	3		2
CO4	2	2	1	3	2	2
CO5	3	3	3	3		2
Overall Correlation of COs and POs	3	2	2	3	2	2

OT5004 EIA AND OCEAN GOVERNANCE L T P C
3 0 0 3

OBJECTIVES:

- To highlight the purpose and role of EIA in the decision-making process
- Know formats of EIA Report (Environmental Impact Statement, or Environmental Statement)
- Understand the purpose of developing follow-up procedures, and options for designing these procedures in essential sectors according to the issues
- To understand the various law and ocean governance in CRZ for proper development of ICZM plan

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.

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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

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 EIA for 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 –EIA AND OCEAN GOVERNANCE

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		1		2		2
CO2	2	2	1	3		
CO3		3	2	2		
CO4	2	3	3	3	2	3
CO5	3	3	3	2	2	3
Overall Correlation of COs and POs	2	3	3	2	2	3

OT5005 OCEAN RENEWABLE ENERGY L T P C
3 0 0 3

OBJECTIVES

- To highlight the need for exploring alternative energy sources especially renewable sources like ocean energy.
- To facilitate the students to achieve a clear conceptual understanding on ocean thermal energy conversion, tidal, wave energy and the technologies involved in its operation and maintenance.

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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

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TOTAL: 45 PERIODS

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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 – OCEAN RENEWABLE ENERGY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3		3
CO2	2	2	2	3	2	2
CO3	2	2	2	3		2
CO4	3	3	2	3	3	3
CO5	3	2	3	3	3	3
Overall Correlation of COs and POs	2	2	2	3	3	3

OT5006 COASTAL HAZARDS AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To provide students understanding of the major natural and coastal hazards: floods, earthquakes, tsunamis, landslides
- To manage these hazards based on the laws, policies and disaster management strategies

UNIT I INTRODUCTION 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 -Bioshields - community based disaster management systems- indigenous knowledge for disaster management - NDMA guidelines - Building codes, land use planning and disaster management.

UNIT V CASE STUDIES **9**

Green card concept - Reduction of carbon footprints - Case studies of Earthquake (Bhuj), tsunami (2004 Indian Ocean tsunami), cyclones (supercyclone,1999 Odisha), other cyclones, coastal erosion, oil spills, chemical disasters, nuclear disasters - vulnerability of coastal megacities - lessons from building back better.

TOTAL: 45 PERIODS

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
7.

CO – PO MAPPING –COASTAL HAZARDS AND MANAGEMENT

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	1	3		1
CO2	2	2	1	3		2
CO3		2	3	3		2
CO4	2	2	3	3	2	2
CO5	3	2	3	3	2	3
Overall Correlation of COs and POs	2	2	3	3	2	2

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OT5007 INTEGRATED COASTAL ZONE MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

- To understand the need for integrated coastal management
- To study the goals, framework and prioritizing issues in ICM
- To know the basic regulation associated with the coastal zone protection and management

UNIT I THE NEED FOR ICM ANDFUNDAMENTAL CONCEPTS 9

Introduction: The Coasts – Unique, Valuable and Threatened –Examples of Interactions among Coastal and Ocean Uses and Their Environments – Early Efforts at Coastal Management - The Need for ICM

UNIT II ICM FRAME WORK AND PROCESSES 9

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

UNIT III ICM TOOLS AND TECHNIQUES 9

Administrative tools – policy and legislation, zoning, regulation and enforcement, spatial planning, marine spatial planning; 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 INTEGRATING DISCIPLINARY PERSPECTIVES 9

Social science insights – Natural science insights – Horizontal integration – Vertical integration – Problem and objective analysis– Developing indicators for Monitoring and evaluation, adaptive management.

UNIT V COASTAL LAWS, POLICIES, INSTITUTIONS AND GOVERNANCE 9

Introduction to Environmental Law and Policy - Laws and policies dealing with environment and coast. Coastal Regulation in mainland India- Coastal regulation zones for islands– Institutions for ICM. International Law and Policy - Law of the Sea [UNCLOS] - Institutions and Governance Mechanisms.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Explain the basic fundamentals of ICM
CO2 Develop ICM framework based on various processes.
CO3 Assess the risk by using various tools and technique in ICM
CO4 Comprehend how different disciplines including engineering and social sciences are integrated
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 - INTEGRATEDCOASTAL ZONEMANAGEMENT

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			1			
CO2		2	2			2
CO3			3	3	3	2
CO4	2	2	3	3		2
CO5	2	2	3			
Overall Correlation of COs and POs	2	2	3	3	3	2

OT5008 COASTAL ECOSYSTEM AND BIODIVERSITY L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I COASTAL 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

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 by marine 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 - COASTAL ECOSYSTEM AND BIODIVERSITY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2			3
CO2	2	2	2			3
CO3		2	2			3
CO4	2	2	2			2
CO5	2	2	1			2
Overall Correlation of COs and POs	2	2	2			3

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OT5009 **GLOBAL CLIMATE CHANGE AND OCEANS** **L T P C**
3 0 0 3

OBJECTIVES:

- To give students the various perspectives on climatic change and the actions societies have taken to address its potential and actual impacts.
- To highlight that natural processes and human activities alter the composition of the ocean and atmosphere, both globally and regionally, that trigger climate change at different temporal and spatial scales.
- To provide a basic conceptual understanding of the complexity of the climate system; and the observed and potential effects of anthropogenic-induced climate change on human and natural systems based on IPCC recommendations.
- To enable understanding of the international and national responses to climate change and consider individual responsibility and future challenges.

UNIT I 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 IMPACTS OF CLIMATE CHANGE 10

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

UNIT IV ASSESSMENT OF CLIMATE CHANGE 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 - Sim-CLIM model - Shared Socio- Economic Pathways (SSPs) -Prediction of future scenarios

UNIT V ADAPTATION AND MITIGATION 9

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

TOTAL: 45 PERIODS

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 with atmosphere

CO3 Classify the various impacts with reference to climate change

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CO4 Asses the impacts of climate change based on various indicators and IPCC Reports
CO5 Develop proper climate mitigation measures and provide necessary adaptations

REFERENCES:

1. Wells, N., "The Atmosphere and Ocean, a Physical introduction", Wiley Chichester, 1997.
2. Houghton, J., "Global Warming: The Complete Briefing", Cambridge University Press 3rd Edition, 2004.
3. IPCC AR5 and AR6 Report, Climate Change, Working Group I, II, and III with Task force Cambridge University Press,2015 and 2022.
4. MoEF, GoI. Indian Network for Climate Change Assessment
5. Climate Change and India: A 4X4 Assessment - A sectoral and regional analysis for 2030s. New Delhi,2010

CO – PO MAPPING –GLOBAL CLIMATE CHANGE AND OCEANS

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	2		2
CO2	2	2	2	3		2
CO3	2	3	2	1		2
CO4	3	3	3	2		2
CO5	2	2	2	2	2	2
Overall Correlation of COs and POs	2	3	2	2	2	2

OT5010 MARINE TOXICOLOGY **L T P C**
3 0 0 3

OBJECTIVES

- To understand the toxicants on environmental and aquatic toxicology and its measurement
- To assess the risks involved by identifying the sources, pathways, effects of PCBs and adopting proper risks assessment of contaminants on communities and ecosystems.

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.

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

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 - MARINE TOXICOLOGY

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2			2
CO2	2	2	2		2	
CO3	2	2	2			
CO4	3	3	2			2
CO5	3	3	3		1	1
Overall Correlation of COs and POs	2	2	2		1	2

OT5011 SOCIO-ECONOMIC ASPECTS OF COASTAL MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I ICM AND THE SOCIAL SCIENCES 9

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

UNIT II STAKEHOLDERS, SOCIETY AND SOCIAL CHANGE 9

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

UNIT III LIVELIHOODS AND CULTURE 9

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

UNIT IV INSTITUTIONS, PROPERTY AND LAW 9

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

UNIT V POLICY AND GOVERNANCE 9

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

TOTAL: 45 PERIODS

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 Southeast Asia”, 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.

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CO – PO MAPPING– SOCIO-ECONOMIC ASPECTS OFCOASTAL MANAGEMENT

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2			3
CO2	3	2				2
CO3	3	2	1			3
CO4	2	1	2	1		
CO5	2	1	2	1		2
Overall Correlation of COs and POs	2	2	2	1		2

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OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction — Drivers for Business Analytics — Applications of Business Analytics: Marketing andSales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportUNIT Ies in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map — Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation –Hypothesis Testing.

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Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesistesting.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) — Processing Data with Hadoop — Introduction to MapReduce — Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) — Real time data collection, saving in NoSQL, implement analyticaltechniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop andMapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R — A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R.Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”,Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

Business Data Analytics

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications,Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety

CO2: Ability to describe fundamentals of maintenance engineeringCO3: Ability to explain wear and corrosion

CO4: Ability to illustrate fault tracing

CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 **OPERATIONS RESEARCH** **L T P C**
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING **9**

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING **9**

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships —Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I **9**

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II **9**

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

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OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING *CONCEPTS* **9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT **9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS **9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL **9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT **9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2– Understand the project management concepts and their various aspects in selection
CO3– Interpret costing concepts with project execution
CO4– Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓			✓	✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher,1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, NewDelhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement incomposite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition — Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – HOT5isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

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UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 - Know the characteristics of composite materials and effect of reinforcement incomposite materials.
CO2 – Know the various reinforcements used in composite materials.
CO3 – Understand the manufacturing processes of metal matrix composites.
CO4 – Understand the manufacturing processes of polymer matrix composites.
CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓							
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5			✓	✓	✓		✓				✓	

REFERENCES:

1. Cahn R.W. - Material Science and Technology — Vol 13 — Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C

3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis — Types, slow fast — Manufacture of charcoal — Methods - Yields and application — Manufacture of pyrolytic oils and gases, yields and applications.

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UNIT III BIOMASS GASIFICATION **9**

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design,construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

NIT IV BIOMASS COMBUSTION **9**

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY **9**

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants — Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generatedCO2 – Gain knowledge on biomass pyrolysis process and its applications

CO3 – Develop knowledge on various types of biomass gasifiers and their operations CO4 – Gain knowledge on biomass combustors and its applications on generating energyCO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley& Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of theLiterature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readabilityCO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

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REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-DisasterDiseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practicefrom multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

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UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

CO1 - Understanding basic Sanskrit language.
CO2 - Write sentences.
CO3 - Know the order and roots of Sanskrit.
CO4 - Know about technical information about Sanskrit literature.
CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 **VALUE EDUCATION** **L T P C**

2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford UniversityPress, New Delhi

AX5095 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

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UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass roOT5democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

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UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers'attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do‘s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya andaparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. ‘Yogic Asanas for Group Tarining-Part-I”:Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont’s) - Verses- 71,73,75,78 (do’s)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.