

**M. Tech. Course in Ocean Technology**  
 [Scheme & Syllabus applicable from Academic Year 2013]  
**Department of Physical Oceanography**

**SEMESTER I (CORE)**

Course Code	Paper	Credit
OCE 3101	Introductory Oceanography	4
OCE 3102	Coastal Engineering	4
OCE 3103	Ocean Lab I	2

**SEMESTER II (CORE)**

Course Code	Paper	Credit
OCE 3201	Advanced Marine Technology	4
OCE 3202	Environmental Ocean Technology	4
OCE 3203	Ocean Lab II	2

**LIST of ELECTIVE COURSES**

Course Code	Paper	Credit
OCE E301	Ocean Dynamics	4
OCE E302	Boundary Layer Dynamics	4
OCE E303	Marine Environmental Pollution	4
OCE E304	Ocean Resources	4
OCE E305	Ocean Instrumentation	4
OCE E306	Integrated Coastal Zone Management	4
OCE E307	Ocean Acoustics	4
OCE E308	Satellite Oceanography	4
OCE E309	Ocean Material Technology	4
OCE E310	Observational Techniques & Instrumentation	4
OCE E311	Global Climate Change and Oceans	4
OCE E312	Numerical Modeling	2
OCE E313	Ocean Dredging Technology	2
OCE E314	Deep Sea Submersibles and Exploration Technology	2
OCE E315	Satellite Image Processing & GIS (Practical)	2

### **SEMESTER III**

OCE 3301 Project Dissertation And Mid Term Evaluation	core	18
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### **SEMESTER IV**

OCE 3401 Project Dissertation Evaluation and Viva Voce	core	18
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### **Semester I**

#### **OCE 3101 INTRODUCTORY OCEANOGRAPHY (CORE) Credit : 4**

##### **Unit I**

General introduction – history of oceanography – expeditions - geomorphology and structures of the ocean floor, Continental slope and shelf - Physical properties of sea water- distribution of temperature, salinity, density and oxygen in space and time – PSU and TEOS-10 - acoustical and optical characteristics of seawater – color of the sea. Ocean waves and tides. Significant wave height and period, wave spectrum, principles of wave forecasting.

##### **Unit II**

Oceanographic platforms: Research vessels and their facilities - Ocean Instruments: measurements of depth, light, temperature, salinity, currents, waves and tides.

##### **Unit III**

Water masses: formation and classification - T-S diagram – water masses of the world oceans – Indian Ocean water masses - identification of water masses. Circulation: general circulation of ocean and atmosphere — Ekman spiral and transport – Currents in the oceans - wind-driven circulation, thermohaline circulation - upwelling and sinking - El-Nino and La-Nina and ENSO.

##### **Unit IV**

Heat budget of ocean: radiation laws-insolation – long wave radiation – effect of clouds – sensible and latent heat transfer- Bowen’s ratio- ocean heat transport – spatio - temporal variability of heat budget terms and net heat balance.

#### **References:**

1. Descriptive Physical Oceanography: An introduction: G.L.Pickard and W. J. Emery, Pergamon, 5<sup>th</sup> edn., 1992.
2. Descriptive Physical Oceanography : M.P.M.Reddy, Balkema, 1st edn., 2001.
3. The Oceans: H.U. Sverdrup, Prentice Hall, 1st edn., 1942
4. Introduction to Physical Oceanography : Robert H. Stewart, e-book, 2005.

5. Principles of Physical Oceanography: G. Neumann & WJ Pierson, Jr., Prentice Hall, 1<sup>st</sup> edn., 1966.
6. Encyclopedia of Oceanography: Fairbridge, Reinhold, 1<sup>st</sup> edn., 1979.
7. Physical Oceanography Vol. I & II: Defant, Pergamon Press, 1<sup>st</sup> edn., 1961.
8. Ocean Currents: G. Neumann, Elsevier, 1<sup>st</sup> edn., 1968.
9. Regional Oceanography: Tomczak M. & J.S. Godfrey, Daya Pub. Co., 2004
10. Ocean Circulation & Climate: Siedler, Church & Gould, Academic Press, 1<sup>st</sup> edn., 2001.
11. Oceanographical Engineering: R.L. Weigul, Dover publication, 1964
12. Instrumentation and Meteorology in Oceanography: Marc and Menn, Wiley, 2012
13. Descriptive Physical Oceanography: Lynne and Tulley, Elsevier, 6<sup>th</sup> edn., 2011

## **OCE 3102 COASTAL ENGINEERING (CORE) Credit : 4**

### **Unit I**

Beach, coast and shore, - Beach features - beach cycles - beach profiles – beach stability - Beach erosion and sedimentation - Engineering aspects in coastal oceanography - Coastal protection structures – natural and artificial – design of shore protection structures, seawalls, groins, breakwaters - Types and factors determining selection and stability of breakwaters. Sand bypassing and artificial beach nourishment - latest technologies in shore protection techniques. Environmental impacts of coastal developments.

### **Unit II**

Ports and harbors – types of ports and harbors, harbor designs – port planning and layout – hydraulic response study analysis for harbor entrances – case studies - environmental issues in port planning and operations - maneuverability and operational requirement of ship in harbors, harbor pollution and control measures - Harbor oscillations, seiches. Inlets – siltation of inlets and harbors – remedial measures. Dredging - dredging equipment - dredging related impact studies and its control. Modern environment friendly dredgers – Dredging Impact Assessment (DIA).

### **Unit III**

Wave-structure interaction – impact of waves on structures – wave forces on different types of structures – Morrison's equation - non-breaking, breaking and broken wave pressure on vertical and inclined walls, wave run up and overtopping. Impact of structures on waves - Wave transformation – wave generated currents - alongshore currents, rip currents and undertow – sediment transport in the coastal regions - suspended and bed load movement – sediment budget – alongshore sediment transport rate – estimation methods – onshore - offshore sediment transport.

### **Unit IV**

Coastal Zone management: History and definition of coastal zone management, land ocean interactions in the coastal zones (LOICZ), Integrated Coastal Zone Management, Sustainable development, Environmental impact assessment studies in the coastal zone.

**References:**

- The Oceans : H.U.Sverdrup, Prentice Hall, 1st edn., 1942  
The Sea : M.N.Hill, Harward, 2<sup>nd</sup> edn., 1963.  
Wind waves : B. Kinsman, Dover Phoenix, 3<sup>rd</sup> edn., 2002.  
Oceanographical Engg. : R.L.Wiegel, Prentice Hall, 1<sup>st</sup> edn., 1964.  
Admiralty Manual of Tides : A.T.Doodson and H.D.Waribun  
Observing and Forecasting  
    Ocean Waves : W.J. Pierson, H.O. Pub. 603, 1<sup>st</sup> edn., 1960.  
Coastal Zone Management : J.F.P. Brathz, John Wiley, 1<sup>st</sup> edn., 1972.  
Basic Coastal Engineering : Robert M.Sorensen, Chapman & Hall, 1<sup>st</sup> edn., 1997  
Physical Modeling in Coastal  
Engineering : R A Dalrymple, Kulwer, 1<sup>st</sup> edn., 1984  
Coastal Engineering : R Silvester, Elsevier, 1<sup>st</sup> edn., 1974  
Ocean Engineering – goals,  
environment, technology : J F Brahtz, Wiley, 1<sup>st</sup> edn., 1968.  
Ocean Engineering : ASCE  
Coastlines, structures and  
breakwaters : NWH Allsop, IST Civil Engn., 2005  
Principles of Physical  
Oceanography : G.Neumann & WJ Pierson, Jr., Prentice  
Hall, 1<sup>st</sup> edn., 1966  
Estuaries: A Physical Introduction : K R Dyer, John Wiley, 1973  
Handbook of Coastal and Ocean  
Engineering, Vol. 1, 2, 3 : J B Herbich, Gulf Professional Publishing;  
1992 - 2000  
Handbook Of Coastal And Ocean  
Engineering : [Young C. Kim](#), World Scientific Publishing  
Company, 2009  
Coasts, Marine Structures and  
Breakwaters- Adapting to change : [William Allsop](#), 2 Volume Set, Thomas  
Telford Publishing, 2010  
Shore protection manual vol. 1,2,3 : [Coastal Engineering Research Center](#), University of  
Michigan Library, 1973  
Dredging, Second Edition:  
A Handbook for Engineers : [R N Bray](#), [A D Bates](#), [J M Land](#), Butterworth-  
Heinemann; 2 edition, 1996  
Handbook of Dredging Engineering: [John B. Herbich](#), McGraw-Hill Professional, 2<sup>nd</sup>  
edn., 2000  
Coastal & deep ocean dredging : [John B. Herbich](#), Gulf Pub. Co. (1975)  
Estuaries: A Physical Introduction : Keith R. Dyer, Wiley, 1998.  
Estuaries: Dynamics, Mixing,  
Sedimentation and Morphology : [David Prandle](#), Cambridge University Press, 2011

**Suggested readings:**

- Stability of Coastal Inlets : P. Bruun and Gerritsen, Amsterdam North Pub., 1<sup>st</sup> edn., 1960.  
The Coastline : R.S.K. Barnes, John Wiley, 1<sup>st</sup> edn., 1977.  
Estuary and Coastline  
    Hydrodynamics : A.T.Ippen, McGraw Hill, 1<sup>st</sup> edn., 1996.  
Waves and Beaches : R.E.Meyer, Academic Press, 1<sup>st</sup> edn., 1972.  
Tides, Surges and Mean  
    Sea level : D.T.Push, John Wiley, 1<sup>st</sup> edn., 1996.

## **OCE 3103 OCEAN LAB 1 (Practical) (CORE) Credit : 2**

Operation and data collection using instruments – data methods and analysis – wave analysis – estimation of currents – isentropic analysis – Ekman currents - Coastal surveys.

### **Semester II**

## **OCE 3201 ADVANCED MARINE TECHNOLOGY (CORE) Credit : 4**

### **Unit I**

Engineering aspects in oceanography - Marine structures and functions – fixed and floating structures – offshore platforms - planning of marine structures – design aspects – loads on marine structures – structural failures - maintenance and protection of underwater structures. Marine materials and its properties. Definition of direct and shear stress and strain, stress-strain behaviour, S.F. and B.M. diagrams, simple theory of bending, Introduction to structural topology of marine structures.

### **Unit II**

Sea bed soil mechanics and its applications in marine structural constructions. Soil mechanics in marine structural design. Offshore pipelines and cables, Oceanographic factors influencing its laying and operations. Maintenance and protection of pipelines and cables. Marine operations for exploration and exploitation, geophysical techniques, underwater mapping and observation of sea floor. Use and applications of marine vehicles. Marine hazards and its management strategies.

### **Unit III**

Desalination. Chemical composition of sea water, saline water conversation and its by-products, different methods for mineral recovery, reverse osmosis, nuclear heat source, comparison of the various sea water receiving process, problems of scale effect on distillation units and methods of removal, electro-dialyses process and its cost effective measures. Economic aspects of desalination.

### **Unit IV**

Resources of the sea: Mineral exploitation, Living and non living resources - oil and gas, exploration techniques. Aquaculture engineering, Design for open sea farming and construction.

### **References:**

- |  |   |   |
|--|---|---|
| Off Shore Structural Engg.   | : | Thomas, H. Dawson, Prentice Hall, 1 <sup>st</sup> edn., 1983.   |
| Advanced Dynamics of Marine Structures   | : | J.P. Hooft, John Wiley and Sons, 1 <sup>st</sup> edn., 1982.    |
| Mining Engineers Hand Book Vol 2   | : | Peele, John Wiley and Sons, 1 <sup>st</sup> edn., 1952.         |
| Introduction to Mineral Exploitation   | : | Antony M. Evans, Blackwell Science, 2 <sup>nd</sup> edn., 1995. |
| Coastal and Deep Ocean Dredging  | : | John B. Herbich, Gulf Pub. Company, 1 <sup>st</sup> edn., 1975. |
| Hand Book of Environmental Laws, acts, Guidelines, compliances and standards Vol 1and 2. | : | R.K.Trivedi, B.S. Pub., 1 <sup>st</sup> edn., 2004.             |
| Saline Water Processing  | : | H.B.Heitmann, John Wiley, 1 <sup>st</sup> edn., 1990.           |

**Suggested readings:**

Measurements and Controls in water desalination, Vol 2	:	Noan Lior, Elsevier, 1 <sup>st</sup> edn., 1986.
Principles of Desalination	:	Spiegler & Lavid, Academic Press, 1 <sup>st</sup> edn., 1980.
Mathematical Modelling in Water Pollution Control	:	A. James, John Wiley and Sons, 1 <sup>st</sup> edn., 1995.
Advances in Water Pollution Research	:	B.A.Southgate, Proc. Conf., 1964.

**OCE 3202 ENVIRONMENTAL OCEAN TECHNOLOGY (CORE) Credit : 4****Unit I**

Ocean resources and utilization – types of resources – identification – estimation of wealth - extraction techniques – appropriate technology for winning materials – Engineering feats – logistics – tools – rigs – platforms – special purpose vessels – environmental concerns – current practices.

**Unit II**

Marine corrosion: Fundamental factors affecting corrosion of metals in water. Marine environmental aspects - different forms of corrosion – pitting, bimetallic (galvanic) corrosion, and deposit attack. Design of corrosion control devices – practical field considerations - anticorrosive and antifouling technology.

**Unit III**

Energy from the sea. Waves, Tide, OTEC, Osmosis, Solar and wind energy systems. Operational aspects and oceanographic factors, new technologies, design and applications, case studies.

**Unit IV**

Marine Information systems, Data management and dissemination of information, feedback and updating mechanisms. Marine surveillance. Law of the sea. Current legislation on the exploitation of the ocean resources, EEZ, Sea Bed Authority, legal principles for conduct of marine scientific research.

**References:**

Advances in Water Pollution Research	:	B.A.Southgate, Proc. London, 1962.
Remote sensing for the Control of Marine Pollution Vol6	:	Jean Marie Massin, NATO, 1984.
Marine Environmental Pollution 2	:	Richard A, Geyer, Elsevier, 2 <sup>nd</sup> edn., 1999.
Marine and Off shore Corrosion Corrosion Engg.	:	Kenneth A Chandler, Butterworth, London, 1 <sup>st</sup> edn., 1985.
Hand book of Oceanographic Engg. Materials	:	Fontana & Greene, Tata McGraw Hill, 3 <sup>rd</sup> edn., 1998.
Cathodic Protection , Theory and Practice	:	Stephen G. Dexter, Wiley, 1 <sup>st</sup> edn., 1979.
Corrosion in Marine Environment	:	V. Ashworth & C.J.L. Booker, Ellis Harwood, 1 <sup>st</sup> edn., 1986.
Bio-deterioration of Materials	:	D.H.Deere, John Wiley, 1 <sup>st</sup> edn., 1977.
Metals hand book, American Society for Metals	:	A. Harry Walters and John J, Elsevier, 1 <sup>st</sup> edn., 1968.
Ocean Wave Energy Conversion	:	International Metals Park, Uty Michigan, 1 <sup>st</sup> edn., 1987.
Wave Energy - a Design Challenge	:	Michael E. Mc Cormick, Wiley, 1 <sup>st</sup> edn., 1981.
	:	R.Shaw, Halsted Press, 1 <sup>st</sup> edn., 1982.

Tidal Power	:Institution of Civil Engineers, U.K, Plenum, 1 <sup>st</sup> edn., 1972.
Ocean Engg. - Goals,Environmental Technology	:J.F. Brahtz, Wiley, 1 <sup>st</sup> edn., 1968.
Corrosion Engineering : Principle and Practice	: P.Roberge, McGraw Hill, 2008.

**OCE 3203 OCEAN LAB II (Practical) (CORE) Credit : 2**

Programming : variables and data types - built-in function – statement function – formatting – logical operations – looping – arrays – subprograms – file operations.

Graphical tools: Generic Mapping Tools (GMT), ferret

Ocean data processing: physical properties of sea water – T-S diagram – water mass – heat budget – ocean circulation - ENSO

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**Elective courses**

**OCE E301 OCEAN DYNAMICS (ELECTIVE) Credit : 4**

**Unit I**

Fluid Dynamics - fluid continuum, fluid properties, ideal fluid, actual fluid, types of flow, compressible and incompressible fluid - equation of continuity and its applications.

**Unit II**

Eulerian equation of motion - laminar flow and turbulent flow, Navier stokes equation of motion for a viscous Newtonian fluid - Reynolds number and significance. Navier Stokes equations. Equations of motion in the rotating frame.

**Unit III**

Laminar and turbulent flows, Reynold’s equation of motion, Reynold’s stresses. Current’s without friction, Geostrophic currents, relative currents, slope current, inertia currents, computation of relative currents.

**Unit IV**

Currents with friction, Ekman’s spiral, Ekman’s transport, Sverdrup’s equation and its application, Westward intensification of ocean currents, major currents of the oceans. Munk’s theory on ocean circulation. Long waves, Kelvin’s waves, Rossby waves.

**References:**

Principles of Physical Oceanography	:W J Pierson and G Neumann, Prentice Hall, 1 <sup>st</sup> edn., 1966.
Dynamical Oceanography	:J Proudman, Methuen, 1st edn., 1953.
Introductory Dynamical Oceanography	:S Pond and G L Pickard, Pergamon Press, 1 <sup>st</sup> edn., 1983.
Introduction to the Physical Oceanography	:W S Von Arx, Addison Wesley, 1 <sup>st</sup> edn., 1962.
Ocean Currents	:G Neumann, Elsevier, 1 <sup>st</sup> edn., 1968.
Wind Waves	:Kinsman, Courier Dover, 3 <sup>rd</sup> edn., 2002.

Oceanographic Engineering

:R L Weigal, Prentice Hall, 1<sup>st</sup> edn., 1964.

**Suggested Readings:**

Physical Oceanography Vol I & II  
General Oceanography  
The Oceans  
The Tides  
The Sea. Vol I & II

:A Defant, Pergamon, 1st edn., 1961.  
:Deitrich, Interscience, 1st edn., 1963.  
:H U Sverdrup, Prentice Hall, 1st edn., 1942.  
:H Darwin, Adamant Media, 1st edn., 1987.  
:M N Hill, John Wiley, 1st edn., 1974.

**OCE E302 BOUNDARY LAYER DYNAMICS (ELECTIVE) Credit : 4**

**Unit I**

Planetary boundary layer. Scales of interaction. Structure of turbulence. Some mathematical and conceptual tools – statistics. Statistical description of turbulence. Similarity theory. Evaluation of heat, momentum and evaporation fluxes across the boundary, wind stress over the sea and its computation and importance.

**Unit II**

Ocean mixed layer – processes and mixing – isopycnal, diapycnal – double diffusion – convergence and divergence – estimation.

**Unit III**

Tropics – ITCZ - circulation of ocean and atmosphere – tropical cyclones – storm surges – tornadoes. Effects of side boundaries. Coastal upwelling. Kelvin waves. Planetary waves.

**Unit IV**

Instability, fronts and general circulation, Measurement of air-sea interaction products, Sensors, Platforms and remote observing system.

**References:**

Atmosphere – ocean dynamics  
Physics of the Marine Atmosphere  
Structure of the atmospheric boundary  
Layer  
An introduction to boundary layer  
Meteorology  
Boundary Layer Dynamics

:Gill Adrian E, Academic Press, 1st edn., 1982.  
:Roll H. U., New York Pub., 1<sup>st</sup> edn., 1965.

:Sorbjan Zbigniew, Prentice Hall, 1st edn., 1989.

:Stull Roland B, Springer, 1<sup>st</sup> edn., 1988.

:[Panel on Boundary Layer Dynamics](#), National Academies Press, 1997

Modeling and Computation of  
Boundary-Layer Flows: Laminar,  
Turbulent and Transitional Boundary  
Layers in Incompressible and  
Compressible Flows  
An Introduction to Fluid Dynamics  
Air-Ice-Ocean Interaction-  
Turbulent Ocean Boundary Layer  
Exchange Processes  
The Near-Surface Layer of the Ocean –  
Structure, Dynamics and Applications  
Atmosphere, Ocean and Climate  
Dynamics - An Introductory Text

:[Tuncer Cebeci](#) and [Jean Cousteix](#), Springer, 2005.

:[G. K. Batchelor](#), Cambridge University Press, 2000

:[Miles McPhee](#), Springer, 2008

:[A. Soloviev](#) and [Roger Lukas](#), Springer, 2006.

: [J. Marshall](#) and [R. A. Plumb](#), Academic Press, 2006.



## **OCE E303 MARINE ENVIRONMENTAL POLLUTION (ELECTIVE) Credit : 4**

### **Unit I**

General aspects of Pollution - kinds of pollution, Types of pollutants – classification and characteristics of pollutants.

### **Unit II**

Marine environmental pollution, major pollutants - oil, sewage, chemicals and hazardous materials, thermal, radioactive. Industrial pollutants, ship breaking and associated issues, ocean dumping and litter. Impact and fate of pollutants, pathways of pollutants, bio-availability, bioaccumulation, bio-magnification.

### **Unit III**

Hydrodynamic aspects in coastal and open ocean disposal of pollutants, control measures. The transport phenomenon, advective and diffusion aspects, initial dilution.

### **Unit IV**

Monitoring strategies, monitoring and control, standards and implementation, directives from world bodies. Global waste management and the oceans, concepts in carrying capacity, case studies, impact assessment, specific laws on prevention on marine pollution under LOS.

### **References :**

- |  |   |
|--|---|
| Advances in Water pollution Research                                   | :B A Southgate, Pergamon, 1 <sup>st</sup> edn., 1964.         |
| Remote Sensing for the control of Marine Pollution, Vol. 6             | :Jean Marie Massin, Plenum Press, 1 <sup>st</sup> edn., 1984. |
| Marine Environment Pollution   | :Richard A Geyer, Elsevier, 1 <sup>st</sup> edn., 1981.       |
| Marine Outfall Systems   | :R A Grace, Prentice Hall, 1 <sup>st</sup> edn., 1978.        |
| Water and Water Pollution  | :L L Ciaccio, Marcel Dekker, 1 <sup>st</sup> edn., 1971.      |
| Dispersion in Estuaries and Coastal Waters                             | :Lewis, Wiley Blackwell, 1 <sup>st</sup> edn., 1997.          |
| Water, Environment and Society in Terms of Climatic Change             | :Essar, Water Soc., 1999.                                     |
| Ocean Zoning   | :T Agardy, Routledge, 2010                                    |
| Protecting the Marine Environment from Land based sources of pollution | :H Daud, Ashgate Pub., 2006                                   |
| Handbook of Marine Pollution   | :E Gold, Assurance Gard, 1985                                 |
| Marine Pollution   | : R B Clark, Oxford Uty Press, 2001                           |

## **OCE E304 OCEAN RESOURCES (ELECTIVE) Credit : 4**

### **Unit I**

Ocean Resources: definition and classification, potential uses of sea. Geophysical and oceanographic operations: direct and indirect methods of data collection on and below sea surface, Involvement of ocean scientists in exploration and exploitation, phases of marine resources.

### **Unit II**

Operational requirements, ports and harbors, vehicle requirements, planning and policy on ocean resources, harvesting food from the sea, extracting or dredging raw materials, sea as a highway, energy generation, military exercises, leisure and tourism, sewage and waste disposal.

### Unit III

Understanding the hostile marine environments, mineral and hydrocarbon resources, exploration, development, and production of hydrocarbons, ocean mining, semi-submersible and their functions, stability, motion and weight.

### Unit IV

The ice environment and operations in extreme weather conditions, offshore safety and rescue. Use of marine robotics and expert systems, machine based operations for solving strategic resource issues.

#### References:

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|--------------------------------------|---|
| The Oceans, Our future               | :M Soares, Cambridge Univ. Press, 1978.                               |
| Oceanology Vol. 6                    | :Soc. Underwater Technology, Graham & Trotman, 1988.                  |
| Descriptive Physical Oceanography    | :W J Pierson and G Neumann, Pergamon, 5 <sup>th</sup> edn., 1990.     |
| Mining Engineers Handbook, Vol. 2    | :Teele, John Wiley, 2 <sup>nd</sup> edn., 1996.                       |
| Introduction to mineral Exploitation | :Antony M Evans, Wiley, 3 <sup>rd</sup> edn., 1990.                   |
| Coastal and Deep Ocean Dredging      | :John B Herbich, Gulf Pub. 1 <sup>st</sup> edn., 1975.                |
| The Sustainable Management of        |   |
| Tropical Catchments                  | :Harper & Brown, Wiley 1 <sup>st</sup> edn., 1999.                    |
| The Ocean Basins and Margins         | :Dercourt, Plenum, Vol.8, 1996.                                       |
| Introduction to Energy Resources,    |   |
| Technology and Society               | :E S Cassdy, Elsevier, 1 <sup>st</sup> edn., 2000.                    |
| Underwater Minerals                  | : D S Cronon, Academic Press, 1 <sup>st</sup> edn., 1980.             |
| Ocean Year Book (Vol 1 – 4)          | : Borges & Ginsburg, The University of Chicago Press, 1983.           |
| Mineral Wealth of the Ocean          | : Ghosh & Mukhopadyay, Oxford & IBH Pub. Co., 2 <sup>nd</sup> , 1999. |

## OCE E305 OCEAN INSTRUMENTATION (ELECTIVE) Credit : 4

### Unit I

Nature of Ocean instrumentation: environmental considerations, design constraints, power requirements, operational features, relevance of in-situ measurements. The architecture of measuring instruments and the relevance of sensors on total performance and accuracy. Ocean parameters and sensors : sensors for tide, waves, water current & direction, orbital velocity, salinity, silt, sedimentation, DO, pH, ammonia, turbidity, wind & direction, RH, Solar radiation, atmospheric pressure, underwater radiation, static and dynamic pressure; speed, vibratos, roll, pitch, heave and acceleration of survey ships.

### Unit II

Basic signal sensing techniques: voltage, current, resistance, inductance and capacitance. Infra red, acoustic, optic and electromagnetic methods. Sensors with very low and very high impedance and special methods for their signal conditioning. Signal conditioners : dc and ac bridge net works, oscillators and modulating/demodulating methods, signal amplifiers and opamps, instrumentation opamps, CMMR, ambient temperature and environmental effects on components and circuits: Data display devices: analogous, digital, alphanumeric, hybrid, barographic displays.

### Unit III

Data storage devices : Charts with analogous , digital and magnetic formats. A/D converters, RAM, ROM, EPROM, EEPROM, solid state, paper chart and magnetic tape storage, Data recording formats and standards. PC interfaces. Data integrating methods for dynamic parameters of wave, current, wind and solar radiation. Data transmission systems; modulation techniques, PCM, relevance of HF, VHF UHF carriers. Satellite transmission networks. Ocean instrument platforms: observation ships, rigid platforms, spar buoys, spherical buoys, mooring techniques. Comparative features of the platforms for different sensors and location specific measurements,

### Unit IV

Portable instruments : ST meter, STD meter, CTD systems Ocean current meter, Silt meter, In-situ Turbidity meter, Underwater LUX meter, DO & pH meters, and composite types. For multi parameter monitoring. Permanently installed types : Tide indicator/Recorder. Wave recorder, Tide and Wave telemetering systems, Shipborne Data Acquisition Systems, Marine Meteorological Data Acquisition Systems, ocean data buoys, wave rider buoys.

### Unit V

Acoustic Instruments : for bottom detection, fish finding, resource estimations, aimed trawling, sub bottom profiling, bottom scanning ( side scan sonar), sonar with PPI display, hydrographic echo sounders, and under water position fixing systems. Computerised data storage methods for resource analysis, multi transducer systems with signal processors for ocean resource scanning, 3-D ocean floor mapping systems. Ocean communication systems: marine radios and regulations, radar, direction finders, Decca/ Loran systems, satellite position fixing systems, GPS and DGPS. Electronic marine safety instruments: Direction finding floating beacons, EPIRB, equipment for marine surveillance.

### References :

- |   |  |
|---|--|
| Instrumentation - Systems and Devices   | : Rangan & Sharma, Tata McGraw Hill, 1 <sup>st</sup> edn., 1997.       |
| Measurement Systems & Applications      | : Earnest O. Doebelin, McGraw Hill, 3 <sup>rd</sup> edn., 1983.        |
| Instruction Manual for Oceanic          |  |
| Observations                            | : U.S.Naval Oceanographic Office, N.Y., 2001.                          |
| Data Analysis Methods in Physical       |  |
| Oceanography                            | : Emery & Thomas, Elsevier, 2 <sup>nd</sup> edn., 2001.                |
| Marine Optics                           | : Jerlov, Elsevier, 1 <sup>st</sup> edn., 1976.                        |
| Fundamentals of Salt Water Desalination | : Howe, Elsevier, 1 <sup>st</sup> edn., 2002.                          |
| Chemical Methods for use in             |  |
| Marine Environmental Monitoring         | : Manuals and Guide Vol 12, IOC, 1998.                                 |
| Instrumental Methods of Analysis        | : Willard, Merrit & Dean, C B S Pub., 1 <sup>st</sup> edn., 1992.      |
| Physics of the Environment and Climate  | : Gerard Guot, John Wiley, 1 <sup>st</sup> edn., 1996.                 |
| The use of Radar at Sea                 | : Capt.F.J.Wylie, Hollis & Carter, 1 <sup>st</sup> edn., 1952.         |
| Admiralty Manual of Seamanship          | : Her Majesty's Stationery Office, London, 1968.                       |
| Under water Engg. Surveys               | : Milne, Gulf Pub., 1 <sup>st</sup> edn., 1980.                        |
| Oceanology Vol 6                        | : Soc. Underwater Tech., Graham & Trotman, 1 <sup>st</sup> edn., 1986. |
| Hand book of Meteorological             |  |
| Instruments                             | : HMSO London, 1988.   |

## **OCE E306 INTEGRATED COASTAL ZONE MANAGEMENT (ELECTIVE) Credit : 4**

### **Unit I**

Coastal zone management – concepts, definition and techniques. Introduction to integrated management – Coastal ocean processes and ICZM. Coastal features and marine influence on coastal development.

### **Unit II**

Matrix on ICZM. Systems approach. Balanced budget on use and preservation of resources of the coastal zone. Resource management of coastal regions. Sustainable development – sector interplay in coastal zone – solution through management.

### **Unit III**

Strategic planning – objectives and policy – conceptual framework in ICZM - EIA and DPSIR – adaptive techniques – feedback mechanisms – case studies. Coastal vulnerability. Methods for evaluation of coastal status. Capacity building – technology transfer issues, field experiences and solutions.

### **Unit IV**

Acts and legislation on CZM. Implementation of policies. Traditional practices, values and emerging modern technological innovation. Marine Spatial Planning and developmental approaches in Coastal Zone.

### **References:**

- Ecosystems at the Land Sea Margins  
– Drainage Basin to Coastal Seas : Thomas, Smodlaka & Turner, AGU, 1<sup>st</sup> edn., 1999.
- Large Scale Constructions in Coastal  
Environments : Vollmer and Grann, Springer Verlag, 1<sup>st</sup> edn., 1998.
- Fluvial Process and Environmental change : Brown, John Wiley, 1<sup>st</sup> edn., 1999.
- Coastal Erosion – Response and  
Management : Charlier and Meyer, Springer Verlag, 1<sup>st</sup> edn., 1998.
- Mixing in Estuaries and Coastal Seas : Pattiaratchi, AGU, 1996.
- Coastal Zone Management -  
Coastal Management : Salomons, Springer, 1<sup>st</sup> edn., 2001.
- Coastal Zone Management (2 Vol.) : Korakandy Kalpaz Publications, 1<sup>st</sup> edn., 2005
- GIS For Coastal Zone Management : Bartlett Darius, CRC Press, 1<sup>st</sup> edn., 2003.
- Introduction -Coastal Zone Management : Beatley Timothy, Island Press, 1<sup>st</sup> edn., 2002.
- ICZM for Coral Reefs: Decision Support  
Modeling : Gustavson, Huber, Ruitenbeek, World Bank Pub., 1999.
- Integrated Coastal Zone Management  
(ICZM) The Global Challenge : R R Krishnamurthy, Research Pub. Services, 2002.
- Coastal Planning and Management : Robert Kay, Taylor & Francis, 2<sup>nd</sup> edn., 2005.
- Integrated CZM : Erland M, Wiley – Blackwell, 2009
- Sustainable Coastal Management &  
Climate Adaptation : R Kenchington, CRC Press, 2012
- Sea Level Rise, Coastal engineering,  
Shorelines and Tides : Linda L W, Nova Science Pub., 2011.

## OCE E307 OCEAN ACOUSTICS (ELECTIVE) Credit : 4

### Unit I

SONAR systems. Transducers and their directivities. Transducer arrays. Array steering. Shaped transducers. High power transducers.

### Unit II

Fourier representation of signals. Filters and noise. Temporal resolution and bandwidth. Improving signal to noise ratio.

### Unit III

Perception of bodies and bubbles by scattering phenomena. Scattering characteristics of marine life. Signals scattered by fish and other bodies. Volume scattering in the ocean. Field estimate of fish densities.

### Unit IV

Sediment characteristics. Marine seismic measurements. Headwaves. Reflection measurements. Echo sounding of the sea floor.

### Unit V

Diffraction of impulsive signals. Doppler effect of moving objects. Doppler navigation. Mean Squared pressure. Remote sensing of the sea floor. Acoustic tomography.

### References:

- |  |   |
|--|---|
| Fundamentals of Acoustics  | :L.E. Kinsler & A. R. Frey, John Wiley, 1 <sup>st</sup> edn., 2000.   |
| Acoustical Oceanography  | :C S Clay & H Medwin, Academic Press, 1st edn., 1998.   |
| Principles of Underwater Sound   | :D G Tucker & B K Gazey, McGraw Hill, 3 <sup>rd</sup> edn., 2003.   |
| Computational Ocean Acoustics<br>(Modern Acoustics and Signal Processing)                              | : <a href="#">F.B. Jensen</a> , <a href="#">W. A. Kuperman</a> , <a href="#">M. B. Porter</a> and <a href="#">H. Schmidt</a> , Springer, 2nd ed., 2011. |
| Ocean Acoustics: Theory and Experiment<br>in Underwater Sound  | : <a href="#">I. Tolstoy</a> and <a href="#">C. Clay</a> , Acoustical Society of America, 1987.   |
| Ocean Ambient Noise: Measurement and<br>Theory (The Underwater Acoustics Series)                       | : <a href="#">W. M. Carey</a> and <a href="#">R. B. Evans</a> , Springer, 2011.   |
| Fundamentals of Ocean Acoustics<br>(Modern Acoustics and Signal Processing)                            | : <a href="#">L.M. Brekhovskikh</a> and <a href="#">Yu.P. Lysanov</a> , Springer, 3rd edition, 2007.  |
| Ocean Acoustics  | : <a href="#">J.A. DeSanto</a> , Springer, 2009   |
| Sounds in the Sea: From Ocean Acoustics<br>to Acoustical Oceanography                                  | : <a href="#">H. Medwin</a> , Cambridge University Press, 2005.   |
| Fundamentals of Shallow Water Acoustics  | : <a href="#">B. Katsnelson</a> , <a href="#">V. Petnikov</a> and <a href="#">J. Lynch</a> , Springer, 2010.  |
| Advances in Ocean Acoustics - Proceedings<br>of the 3rd International Conference on<br>Ocean Acoustics | : <a href="#">Ji-Xun Zhou</a> , <a href="#">Zhenglin Li</a> and <a href="#">Jeffrey Simmen</a> , American Institute of Physics, 2012.                   |

## **OCE E308 SATELLITE OCEANOGRAPHY (ELECTIVE) Credit : 4**

### **Unit I**

Electromagnetic spectrum : Regions applicable for remote sensing, Physics of remote sensing, effects of atmosphere. Atmospheric windows, scattering, absorption. Spectral reflectance of earth`s surface features in different wave length of EMR. Multispectral remote sensing. Characteristics of space platforms and sensors. Scenario of Indian satellite remote sensing and current operational satellites for Oceanography.

### **Unit II**

Fundamentals of satellite Image Processing: Advanced techniques of image processing and analysis of remotely sensed digital data. radiometric correction, geometric correction, atmospheric and ground effects, image enhancement, spectral analysis, classification, and change detection. Techniques of visual interpretation. Geographic Information System(GIS): Spatial and attribute data , Raster and Vector spatial data structures, thematic characteristics of spatial data, Sources of Oceanographic spatial data-ship and Buoy data, air photos, satellite images, field data. Geographic Information System application and development for coastal zone and ocean.

### **Unit III**

Fundamentals of remote sensing in Oceanography-Visible Remote Sensing: Theory of optical remote sensing , scattering, absorption, radiative transfer. Ocean colour sensors and satellites, Interpretation of ocean colour and applications of Ocean colour scanners. Role of water constituents such as chlorophyll, yellow substances, and Suspended sediments. Use of different algorithms for the retrieval of chlorophyll and sediments.

### **Unit IV**

Infrared Remote sensing: Physics of Infra red radiation, Thermal Structure of oceans, atmospheric correction. Sea Surface Temperature (SST) from Infra red Scanning Radiometers. Algorithm for measurement of SST. Application of SST and useful sensors for retrieval of global SST.

### **Unit V**

Principles of Passive and active Microwave Radiometry: Sea ice monitoring: SST, oil ---spills, Scatterometer: wind, Satellite Altimeter: Emphasis of SARAL for Indian Ocean, Sea Surface topography, Sea surface Hight (SSH), Geostrophic currents, planetary waves.

### **References:**

1. Hyperspectral data, analysis techniques and applications , Navalgund, Ranganath R., 2011, Published by : Indian Society of Remote Sensing
2. Introduction to Remote Sensing, James B. Campbell, Randolph H. Wynne; **2011**, Guilford Press.
3. Discovering the Ocean from Space: The Unique Applications of Satellite oceanography, I.S. Robinson, 2010, Springer

4. Remote sensing of coastal environments, **Wang, Yeqiao**, 2010, **Taylor & Francis series in remote sensing applications, CRC Press** .
5. Introductory digital image processing: A remote sensing perspective by Jensen, Prentice Hall Series in Geographic Information Science (3rd ed, 2005).
6. Measuring the Oceans from space: The principles and methods of satellite Oceanography: I. S. Robinson, 2004, Praxis Publishing, UK
7. Integration of geographic information systems and remote sensing , 1997, Cambridge University Press (Cambridge)
8. Oceanographic Applications of Remote Sensing, Motoyoshi Ikeda, Fred Dobson, 1995.
9. Remote sensing and image interpretation, Lillesand, Thomas M., 2000, John Wiley and Sons, (New York,)
10. Remote sensing applications in marine science and technology , Cracknell, Arthur P., 1982, Reidel publishing (Boston)

## **OCE E309 OCEAN MATERIAL TECHNOLOGY (ELECTIVE) Credit : 4**

### **Unit I**

Thermodynamics and stability of metals , Pourbaix potential- pH diagram. Fundamentals of metallic corrosion; electro chemical nature, different forms of corrosion. Fundamental factors affecting corrosion of metals brackish water and seawater, fundamental factors causing corrosion of metals exposed to atmosphere, inter tidal zones and deep submerged zones.

### **Unit II**

Corrosion behavior of iron and iron alloys including stainless steel, Nickel Alloys, Copper Alloys, Aluminum and aluminum alloys and exotic metals like Titanium, Tantalum and Zirconium, mechanical properties of fouling behavior.

### **Unit III**

Mechanism of chemical attack, corrosion resistance and failure of plastic ocean engineering materials, ceramics mortars, ferro cement, marine concrete, grout, and surfacing compounds. Bio deterioration of wood and problems of marine borer attack. Theory and practice of painting of materials exposed to industrial marine atmosphere and seawater immersed zone.

### **Unit IV**

Recent development in anticorrosive and antifouling technology, economy of smooth hull, fundamentals of under water cleaning and sophisticated coatings. Corrosion monitoring and testing, selecting materials of construction and fundamentals of designing in corrosion prevention. Cathodic protection, theory, principles and engineering.

### **References:**

- |  |  |
|--|--|
| Marine and offshore corrosion                    | :Kenneth A Chandler, Butterworth, 1 <sup>st</sup> edn., 1985.              |
| Corrosion Engineering                            | :Mars G. Fontana and N.D. Greene, McGraw Hill, 1 <sup>st</sup> edn., 1986. |
| Cathodic Protection, Theory and Practice         | :V. Asworth & C.J.L. Booker, Ellis Harwood, 1 <sup>st</sup> edn., 1986.    |
| Hand book of Oceanographic Engineering Materials | :Stephen G. Dexter, Wiley, 1 <sup>st</sup> edn., 1979.                     |
| Ship painting and Corrosion                      | :Deret H Deere, Halsted Press, 1 <sup>st</sup> edn., 1972.                 |
| Bio-deterioration of Materials                   | :A. Harry Walters and John J., Wlsevier, 1 <sup>st</sup> edn., 1968.       |
| Corrosion Engg. Hand Book                        | :P.A. Schweitzer, CRC Press, 2007.   |

Sea water Corrosion Hand Book :M. Schumacher, Noyes Data Corp., 1<sup>st</sup> edn., 1979.  
 Physical Chemistry of Metals :L. Darken and R. Gurry, McGraw Hill, 1<sup>st</sup> edn., 1953.  
 Metals Hand Book, 10th Edition. :American Society of Metals, ASM, 1982.  
 Atlas of Electro chemical Equilibria  
 in Aqueous Solutions :Pourbaix, NAC Engn., 1974.  
 Technical Nomograph No. 35,  
 Standardising Metallic Dimensions :D. Bush, Elsevier, 1999.  
 Metals and Alloys in Uniform  
 Numbering System :Society of Automotive Engineers Inc. 5<sup>th</sup> edn.  
 Development in Reinforced Plastics:T.F.Anderson and V.B. Messic, Applied Science, 1<sup>st</sup> edn., 1980.

## **OCE E310 OBSERVATIONAL TECHNIQUES AND INSTRUMENTATION (ELECTIVE) Credit : 4**

### **Unit I**

Marine surveys, hydrographic survey, gravitational and magnetic surveys. Ship borne and air borne surveys of living and non living resources. Coastal navigation: Navigation warnings. Coastal marks and buoys, sounding, tides and tidal streams. Visual fixing. Fixing by radar and radio aids to navigation.

### **Unit II**

Marine navigation, the Navigators surface, the sphere and co-ordinates of position , terrestrial magnetism, charted representation of the earth's surface, Navigational instruments, Basic stellar fixing. Direction, distance and coastal positioning instruments: Magnetic and gyro compass, logs, sextant, bearing instruments- Pelorus and azimuth mirror, chronometer. Electronic aids to navigation: Radar, echo sounders, SONAR, Direction finder, Decca system of navigation, GPS and DGPS.

### **Unit III**

Measurement techniques, sensors and instruments: Oceanic parameters and their conversion to electrical signals. Active and passive sensors. Sensors for tide, wave, salinity, temperature, silt, sedimentation, water current & direction, underwater radiation. Pressure sensors for tide and waves. Acoustic sensors for measurement of speed, current& direction, tide, depth, sound velocity. Strain gauge type sensors. Sensors for ship borne, air borne and buoys, Design and materials requirements of sensors for marine environment. Signal conditioners and standards. Electronic instruments for marine environmental measurements, ocean dynamics and marine meteorology.

### **Unit IV**

Data telemetry, Wire telemetry, modems, wireless telemetry, modulation technique, binary and PCM. Methods in data transmission. HF, VHF and UHF carrier waves for communication. Data acquisition, Principles and problems of direct and indirect measurements by sea borne systems. Airborne and satellite remote sensing systems, photographic and scanning. Sensor platforms. Types and characteristics of imaging the emission, radiation and reflection of electromagnetic energy, atmospheric influences.



## Unit V

Data processing and storage: Raw and processed positional data. Storage systems and methods, A/D converters and data storage in solid state devices. Data presentation, charts, electronic and graphic presentation, Mapping, airborne and satellite imaging, Interpretation, analyses and processing systems, Digital image processing techniques. Design of applicable data base, Error detection and trapping, management systems, Data exchange, structure, Specification and format of storage media and techniques.

### References:

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|---|--|
| Environmental Instrumentation                                       | :Leo J.Pritschen & Loyd W. Gay, Springer Verlag, 1 <sup>st</sup> edn., 1979. |
| Evaluation, comparison and Calibration of Oceanographic Instruments | :UNESCO, Paris, 2002.  |
| Theory and Applications of Electric Circuits in SI units            | :Joseph A. Edminister, Academic Press, 2006.                                 |
| Microelectronics  | :Jacob Milman & Aravir Gabel, McGraw Hill, 1 <sup>st</sup> edn., 1988.       |
| Digital Principles and Applications                                 | :A.P.Malvino & D. Loach, CRC Press, N.Y., 2003.                              |
| Instrumentation : Systems and Devices                               | :C.S.Rangan & G.R.Sharma, Springer Verlag, 2004.                             |
| Measurement Systems: Applications                                   | :Earnest O. Doebelin, McGraw Hill, 1 <sup>st</sup> edn., 1978.               |
| Instruction Manual for Oceanic Observations                         | :U.S. Naval Oceanographic Office, H.O.Pub. 607                               |
| Methods of Sea Water Analysis                                       | :K. Grasshoff, Weinheim, 3 <sup>rd</sup> edn., 1994.                         |
| Fundamentals of Sea Water Analysis                                  | :E.D.Howe, Verlag Chemie, 1 <sup>st</sup> edn., 1983.                        |

### Suggested readings:

- |   |  |
|---|--|
| Chemical Methods for use in Marine Environmental Monitoring | :Manuals and Guides, Vol 12, IOC                                 |
| Instrumental Methods of Analysis                            | :Willard, Merrit & Dean, Elsevier, 2007.                         |
| Physics of the Environment and Climate                      | :Gerard Guot, Academic Press, California, 2005.                  |
| The use of Radar at Sea                                     | :Capt. F.J.Wylie, Hollis and Carter, 1 <sup>st</sup> edn., 1952. |
| Admiralty Manual of Seamanship, Vol 111                     | :Her Majesty's Stationery Office, London, 1967.                  |
| Under water Engg. Surveys                                   | :P.H.Milne, Gulf Pub., 1 <sup>st</sup> edn., 1980.               |
| Oceanology Vol 6  | :Graham Trotman, Crown Press, Seattle, 1990.                     |
| A Pictorial history of Oceanography                         |  |
| Submersibles  | :J.B.Sweeney, Crown Pub., 1 <sup>st</sup> edn., 1970.            |
| Introduction to Physical Oceanography                       | :W.S. Vance, Wiley, 1 <sup>st</sup> edn., 1961.                  |
| Hand book of Meteorological Instruments                     | :HMSO, London, 2003.   |

## OCE E311 GLOBAL CLIMATE CHANGE AND OCEANS (ELECTIVE) Credit : 4

### Unit I

Basic concepts in climate change - Role of oceans in climate - Indicators of climate change – short and long term observations – Forecast and Predictions – Study on parameters related to climate change.

## Unit II

IPCC and results – substantive results and findings - AR5 – Linkage to Marine Environment – science behind climate change – key scientific findings. The Kyoto protocol – global emission and climate negotiations – oceans as sink ? – regional studies – beyond Kyoto.

## Unit III

Marine weather and climate change – recorded long term changes – past and future changes in wind waves, storm surges, extreme marine events in past 100 years – climate modeling – preliminary results – GH gases and feedback system – The Carbon cycle – responses from ecological systems - anthropogenic influences on climate change.

## Unit IV

The ocean conveyor belt – influence on circulation patterns – SST – marine biodiversity and SLR – ocean acidification – ice sheet melt and coastline degradation. Indian context – national policy and climate change – likely impacts and mitigation measures.

### References:

1. Climate Change 1992 : Report – IPCC, J T Houghton, C A, Callander & S K Varney
2. Climate Change 2001, 2008 : Synthesis Report – IPCC, 2002, 2008
3. Climate Process and Change :E Bryant, Cambridge Univ. Press, 1<sup>st</sup> edn., 1997.
4. Global Environmental Change – Past, Present and future : K K Turekian, Prentice Hall, 1<sup>st</sup> edn., 1996.
5. Global Warming – The Complete Briefing :J Houghton, Cambridge Univ. Press, 1<sup>st</sup> edn., 1997.
6. Assessing the impact of Climate Change on Natural Resource System : Frederick & Rosenberg, Kulwer Academic, 1st edn., 1994.
7. Visualizing Climate Change : Sheppard and Stephen, Routledge London, 2012.
8. Sea Level Rise, Coastal engineering, Shorelines and Tides :Linda L W, Nova Science Pub., 2011.

## OCE E312 NUMERICAL MODELING (ELECTIVE) Credit : 2

### Unit I

Introduction - modeling issues – numerical computing – accuracy – rate of convergence – efficiency; computational environment - governing equations – approximations and representations- parameterization - boundary conditions -physical and numerical modeling.

### Unit II

Finite difference methods – advection equations -computation errors - Implicit and explicit finite difference schemes- leap-frog scheme, Euler’s scheme, Von Neumann method, Trapezoidal Implicit schemes - stability criteria- computational instability.

### Unit III

Concepts of ocean models - numerical modeling of ocean processes- Cox’s model of Indian Ocean – POM, ROMS models. Model validation - data assimilation and calibration of models – nowcast, forecast and prediction- forecasting ENSO.

## References:

- Introductory Dynamical Oceanography : S. Pond & G. L. Picard, Butterworth-Heinemann, 1983.  
Modeling marine processes : Phil Dyke, Prentice Hall, 1996.  
Computer modeling in Atmospheric and Oceanic Sciences : Peter Muller and Hans Von Storch, Springer, 2004.  
Numerical Modeling of Oceans and Oceanic Processes : L. H. Kantha & C. A. Clayson, Academic Press, 2000.  
Ocean modelling for beginners using open source software : Jochen Kampf, Springer, 2007.  
Dynamics & Modeling of Ocean waves : Komen et al., Cambridge University Press, 1994.  
Introduction to the modeling of Marine eco-systems : W. Fennel & T. Newmann, Elsevier, 2004.  
Numerical modeling of Ocean Dynamics : Z. Kowalik & T. S. Murthy, World Scientific, 1995.  
Modeling and prediction of the upper layer of the ocean : E. B. Kraus, Pergamon Press, 1977.  
Ocean Circulation Physics : M. E. Stern, Academic Press, 1975.  
Numerical modeling of marine Hydrodynamics – Application to Dynamic Physical Processes : H. G. Ramming & Z. Kowalik, Elsevier, 1980.  
Numerical Prediction and Dynamic Meteorology : Haltiner, J. and R. T. Williams., 2nd Ed., Hoboken, NJ: John Wiley & Sons, 1980.  
Numerical Ocean Circulation Modeling : H. Dale and A. Beckmann, NJ, Imperial College Press, 1999.  
Ocean Circulation and Climate : G. Sielender, J. Church and J. Gould, Vol. 77, Academic Press, 2001.  
Coupled Ocean Atmosphere Models : [Nihoul, J C J](#), Elsevier, 1985.

## OCE E313 OCEAN DREDGING TECHNOLOGY (ELECTIVE) Credit : 2

### Unit I

Concept of dredging – type of dredging – win material, removal, trans-placement and recycle – natural ocean environment – fluvial to deep sites.

### Unit II

Basic dredging processes – chemical and mechanical methods, extraction processes – transportation and disposal – dredging techniques, dredgers and principles – operational factors, physical conditions, site selection and environmental survey, field investigations.

### Unit III

Design of dredged area, fill characteristics - monitoring, measuring, quantification and management – offshore applications – lift methods – underwater construction and dredging.

## References:

1. Dredging – A handbook for Engineers : R N Bray, Butterworth, 2<sup>nd</sup> edn., 1996.
2. Environmental Aspects of Dredging : R N Bray, Taylor and Francis, 1<sup>st</sup> edn., 2008.
3. Coastal and Deep Ocean Dredging : J. B. Herbich, Gulf Pub., 1<sup>st</sup> edn., 1975.
4. Basic Coastal Engineering : Robert M. Sorensen, Chapman & Hall, 1<sup>st</sup> edn., 1997.
5. Physical Modeling in Coastal Engineering: R A Dalrymple, Kulwer, 1<sup>st</sup> edn., 1989.
6. Coastal Engineering : R Silvester, Elsevier, 1<sup>st</sup> edn., 1974.
7. Oceanographic Engineering : R L Weigel, Prentice Hall, 1<sup>st</sup> edn., 1964.
8. Ocean Engineering : ASCE, Los Angeles, 2005.
9. Coastlines, structures and breakwaters : NWH Allsop, IST Civil Engn., 2005.

## **OCE E314 DEEP SEA SUBMERSIBLES AND EXPLORATION TECHNOLOGY (ELECTIVE) Credit : 2**

### **Unit I**

Deep sea probes – rationale for use of submersibles – manned and unmanned submersibles – advantages and disadvantages. Technological applications.

### **Unit II**

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

### **Unit III**

Study of reef and shelves – applications in marine geology – survey of pipe lines, cables – ocean waste disposal sites – certification and safety standards.

#### **References:**

1. Manned Submersibles : Rank Busby, U S Navy 1<sup>st</sup> edn., 1976.
2. Submarines and Submersibles : Lock, Deborah, D K Pub. , 1<sup>st</sup> edn., 2007.
3. [Ships Beneath the Sea A History of Subs and Submersibles](#) : Robert F. Burgess, McGraw Hill, 1<sup>st</sup> edn., 1975.
4. [Vessels for underwater exploration](#) : Peter R Limburg, Crown Pub., 1<sup>st</sup> edn., 1973.
5. [A source book of submarines and submersibles](#) : Anthony John Watts, Ward Lock, 1<sup>st</sup> edn., 1976.
6. [Subsea Manned Engineering](#) : Gerhard Haux, Best Pub. Comp., 1<sup>st</sup> edn., 1982.
7. [Handbook for Rov Pilot-Technicians](#) : Chris Bell, Penn Well Books, 2<sup>nd</sup> edn., 1994.
8. [Undersea frontiers; exploring by deep-diving submarines](#) : Gardner Soule, Tand McNally, 1<sup>st</sup> edn., 1968.

## **OCE E315 SATELLITE IMAGE PROCESSING AND GEOGRAPHIC INFORMATION SYSTEMS (GIS) [Practical] (ELECTIVE) Credit : 2**

Processing of Remote Sensing data : Geometric correction – comparisons of nearest neighborhood substitution, Cubic Convolution & bilinear interpolation methods. Radiometric correction techniques: Enhancement , atmospheric corrections for multispectral data by dark pixel method. Cloud elimination techniques, rationing, principal component analysis. colour display techniques, Classification methods: supervised and unsupervised classification techniques for coastal zone.

Oceanographic data base creation by using GIS, Thematic layers connected to ocean and various applications. Coastal zone data base creation from satellite data and analysis for assessment of change detection.

Analysis by available Remote Sensing image processing & GIS software: IDRISI: SeaDAS, ENVI, ERDASIMAGINE, Arc-View and ILWIS Arc-info. Data: OCM, MODIS-Ocean color, NOAA, MODIS-SST, Landsat, IRS-LISS and Landsat-ETM: coastal habitat

**OCE 3301 PROJECT DISSERTATION and MID TERM EVALUATION  
(CORE) Credit : 18**

To get a “hands on” experience in various fields of Ocean Technology in which the Institution/Department is specializing in with due supervision of a guide during the third semester.

**OCE 3401 PROJECT DISSERTATION EVALUATION AND VIVA VOCE  
(CORE) Credit : 18**

This semester program is a continuation of third semester, to be undertaken by the candidate under the supervision of a guide. The student will be required to work either at the home department or at any of the Institutes/IIT/Research centers /Departments etc. where a guide will be assigned for the conduct of dissertation comprising of a piece of work which should be the extension of researches in the field of ocean technology, original in its results and interpretation so as reflect the candidates ability of independent research skills and understanding of the subject. The candidate will submit the work in the form of a thesis which will be examined by internal/external examiners.