M.Sc. Oceanography

Scheme & Syllabus applicable from 2014 Admission

List of core papers

Semester – I

Course Code	Paper	Credit
OCE2101	Introductory Physical Oceanography	4
OCE2102	Geophysical Fluid Dynamics	4
OCE2103	Ocean Instrumentation	3
OCE2104	Ocean Observations and Computations (Practical)	2
ELECTIVE		
ELECTIVE		

C = 13

Semester – II

Course Code	Paper	Credit
OCE2201	Ocean Dynamics	4
OCE2202	Waves and Tides	3
OCE2203	Coastal and Estuarine Oceanography	4
OCE2204	Dynamical Computations - I (Practical)	1
OCE2205	Coastal Oceanography (Practical)	2
OCE 2206	Oceanographic Application Tools (Practical)	1
ELECTIVE		
ELECTIVE		

C = 15

Semester – III

Course Code	Paper	Credit
OCE2301	Ocean Remote Sensing	4
OCE2302	Ocean Modeling	4
OCE2303	Air Sea Interaction	4
OCE2304	Large Scale Ocean Processes (Practical)	2
OCE 2305	Ocean Modeling (Practical)	1
ELECTIVE		
ELECTIVE		

C = 15

Semester – IV *

Course Code	Paper	Credit
OCE 2401	Project Dissertation**	16

C = 16

List of Electives

Code	Course title	Credits	Pre-requisites
OCE E201	General Oceanography	2	GS
OCE E202	Marine Hazards and Management	2	GS
OCE E203	Marine Pollution	3	GS
OCE E204	Ocean Optics	2	2101
OCE E205	Marine Acoustics	4	2101
OCE E206	Coastal Zone Management – I	3	GS
OCE E207	Coastal Zone Management - II	3	GS
OCE E208	Beach Dynamics	2	2101
OCE E209	GIS in Oceanography	2	GS
OCE E210	Computer programming in Oceanography (Practical)	2	GS
OCE E211	Computer Programming in C (Practical)	2	GS
OCE E212	Estuarine Sediment Dynamics	2	2203
OCE E213	Ocean Circulation	2	2201
OCE E214	Remote Sensing Application (Practical)	2	2101
OCE E215	Dynamical Computations – II (Practical)	2	2204
OCE E216	Marine Remote Sensing Applications	4	GS
OCE E217	Regional oceanography	3	2101/E201
OCE E218	Ocean Engineering	4	2101, 2203

OCE E219	Oceans and Climate Change	4	2101

GS – Graduate in Science

* A student shall register for a minimum of 56 credits in the first three semesters before he/she registers for the fourth semester.

** The student will devote the fourth semester on dissertation work related to a relevant area of specialization either in the department or in an industrial/ research/ academic institution outside the University. They will be sent to different outside organizations based upon their performance in their previous semesters on the consent of the departmental council. All the students have to submit a project dissertation at the end of the semester.

The award of maximum 100 marks for the project dissertation to student is based on:

A) *Continuous assessment by his/her guide based on his/her performance and progress during the course of dissertation work will carry a maximum of 30 marks.*

B) *On submission of the project dissertation, an assessment by the Department Examination Committee constituted by the Department Council, based on a presentation made in the parent department will carry a maximum of 30 marks.*

C) *The Project dissertation submitted by the student at the end of the semester will be evaluated externally for a maximum of 40 marks.*

I SEMESTER

OCE: 2101 INTRODUCTORY PHYSICAL OCEANOGRAPHY (CORE) Credit : 4

Unit I

General introduction, dimension of the oceans, geographical features - Physical properties of sea water, distribution of temperature, salinity, density and oxygen in space and time, PSU and TOES-10, acoustical and optical characteristics of seawater – SOFAR channel shadow zone – color of th e sea.

Unit II

Heat budget of ocean: 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.

Unit III

Water masses: formation and classification – T-S diagram – merits and demerits water masses of the Atlantic, Pacific and Southern Ocean with special reference to Indian Ocean – identification of water masses

Unit IV

Circulation: general circulation of the atmosphere – wind driven currents in the Pacific and Atlantic oceans – wind stress, Ekman spiral major currents of the Pacific and Atlantic Oceans –thermohaline circulation- upwelling- El Nino and La Nina- Walker circulation.

Unit V

Indian Ocean: Major expeditions – wind : Northeast and Southwest monsoon pattern, winds – ocean surface circulation – equatorial current systems – Under currents –circulation in Arabian Sea and Bay of Bengal – Somali Current- Upwelling areas in Indian ocean – mixed layer variability – eddies winter cooling - Indian ocean warm pool and Dipole.

References:

1. Descriptive Physical Oceanography: An Introduction.Ed.6, Talley, Lynne D., 2011, Elsevier.
2. Physical Oceanography, Murty, A. S. N., 2010, A.P.H. Pub.
3. Elements of Physical Oceanography: A Derivative of the Encyclopedia of Ocean Sciences, Steele, John H, 2010, Academic Press.
4. Descriptive Physical Oceanography, Emery, William J., 1982, Pergamon Press (Oxford)
5. Elements of Physical Oceanography, McLellan, Hugh J., 1965, Pergamon press (New York)
6. Descriptive Physical Oceanography, Reddy, M. P. M., 2000, New Delhi Oxford & IBH
7. The Oceans, their Physics, Chemistry and General Biology, H.U. Sverdrup, Prentice Hall, 1969.
8. Physical Oceanography (Vol. 2), Defant, Albert, 1961, New York Pergamon Press.

Additional reading:

1. Descriptive Physical Oceanography: An Introduction: G.L.Pickard and W. J. Emery, Pergamon, 5th Edn., 1992
2. Introduction to Physical Oceanography: R. H. Stewart, e-book, 2005
3. Principles of Physical Oceanography: G.Neumann & WJ Pierson, Jr., Prentice Hall,1st edn.,1966
4. Encyclopedia of Oceanography: Fairbridge, Reinhold, 1st edn., 1979
5. Ocean Currents: G. Neumann, Elsevier, 1st edn., 1968.
6. Regional Oceanography: Tomczak M. & J.S.Godfrey, Daya Publishing House, New Delhi, 2004.
7. Ocean Circulation & Climate: Siedler, Church & Gould, Academic Press, 1st edn., 2001.
8. Oceanographical Engineering: R.L.Weigul, Dover Publication, 1964

OCE 2102 GEOPHYSICAL FLUID DYNAMICS (CORE) Credit : 4

Unit I

Solid, liquid and gases – units – continuum hypothesis – fluid properties – Newton's law of viscosity - pressure – absolute and gauge pressure - Pascal's law – equation of fluid statics – manometer – atmospheric pressure – thermodynamics – equation of state - perfect gas

Unit II

Lagrangian and Eulerian methods – steamline, pathline, streaklines – steady and uniform flows - linear and shear strain – rotation - vorticity and circulation – Kelvin's theorem - one, two and three dimensional flows – velocity potential – stream function – line source and sink - doublet

Unit III

Conservation of mass (equation of continuity) – forces in fluids – conservation of momentum – Euler's equation – Navier- Stokes equation – plane Couette flow - Plane Poiseuille Flow – rotating frame of references – Coriolis force – Bernoulli equation and applications – Reynolds decomposition and its application to continuity and momentum equations

Unit IV

Dimensional analysis - fundamental and derived units – Reynolds, Rossby, Ekman, Mac, Richardson and Froude numbers – Reyleigh method - Buckingham's Pi methods - dimensional similarity – model analysis

References:

1. Fluid Mechanics, Pijush K. Kundu and Ira M. Cohen, 3rd Edn, Elsevier Publishers, 2004.
2. Foundations of Fluid Mechanics, S. W. Yuan, Student International Edition, Prentice Hall, 1970.
3. Fluid Physics for Oceanographers and Physicists: An Introduction to Incompressible Flow, Samual A. Elder and J. Williams, 2nd Edn, Pergamon Pr, 1989.
4. Geophysical Fluid Dynamics, J. Pedlosky, 2nd Edn, Springer, 1992.
5. An Introduction to Theoretical Meteorology, S. L. Hess, Holt, Rinehart & Winston,

1966.

OCE 2103 OCEAN INSTRUMENTATION (CORE) Credit : 3

Unit I

Oceanographic platforms : research vessels and their facilities - aircrafts and satellites – drifting buoys - research towers – submersibles – drifting platforms – mooring –FLIP, Principles of navigation – classical and modern navigational methods – hyperbolic navigation – GPS & DGPS – Projections - Sampling requirements – sampling duration, interval and accuracy.

Unit II

Measurement of ocean depth – Lead sounding - Echo sounder, SONAR – applications - measurement of light - Secchi disc – Turbidity meter, Silt meter, Lux meter- water sampling devices: NRWB – modifications - horizontal water sampler - Rosette sampler- special water sampling devices – sensors and probes for pH, O_2, Nutrients, Chl-a and specific ion electrodes.

Unit III

Temperature measurement: SST measurements from ships, buoys and satellites –subsurface temperature measurements: reversing thermometers, temperature profiling using MBT, XBT - Salinity measurements: evaporation method - titration method – salinity from conductivity – induction method – Autosal - CTD

Unit IV

Measurement of currents: Eulerian current measurements: Direct reading and Recording Current Meters - Acoustic Current Meters - Electromagnetic Current Meters - profiling of currents using ADCP - Lagrangian current measurements : surface and subsurface drifters – ARGO floats - oceanographic gliders. Measurement of waves: surface buoys - subsurface gauges-pressure gauges-resistant gauges. CODAR and Remote sensing method - SAR - measurement of Sea level: concept of geoid - Tide staff, Tide gauge and pressure gauge –- Satellite altimetry – Inverted Echo Sounder - Surface meteorological measurement: atmospheric temperature, pressure, humidity and wind

References:

1. Instruction Manual for Oceanic Observations: U S Naval Oceanographic Office, H.O. Pub. 607, 1955
2. Marine Sciences Instrumentation: Vol.1 ; Gaul, Roy D.; Plenum Press, 1962
3. Marine Sciences Instrumentation: Vol.2; Gaul, Roy D.; Plenum Press, 1969
4. Introduction to Physical Oceanography: Robert H. Stewart, e-book, 2005.
5. Principles of Physical Oceanography: W J Pierson and G Neumann, Prentice Hall, 1966.
6. Descriptive Physical Oceanography: An Introduction: G. L Pickard and W.J Emery, Oxford Pergamon Press, 2003.
7. Introduction to Physical Oceanography: W. S. Von Arx, 1962(1st ed.)
8. The Oceans- Their physics, chemistry and general biology: Sverdrup, Prentice Hall, 1942
9. A Pictorial History of Oceanography Submersibles: J B Sweeny, London Robert Hale Company, 1970.
10. Oceanography from Space: J F R Grower, New York, Plenum Press, 1980.
11. Data Analysis Methods in Physical Oceanography: William J. E and Richard E. Thomson; Pergamon, 1997

12. Measuring the Oceans from Space: Principles and Methods of Satellite Oceanography : Robinson, Ian S., Springer, 2004.
13. A Practical Handbook of Seawater Analysis, Strickland and Parsons, 2nd Edn, Miscellaneous Special Publications-Fisheries Research Board of Canada, 1972.

OCE 2104 OCEAN OBSERVATIONS AND COMPUTATIONS (Practical) (CORE) Credit : 2

Use and operation of instruments on board - GPS, Lead sounding - Echo Sounder, NRWB, Niskin and Horizontal water samplers, BT, XBT, CTD, Salinometer, Current meters, Tide guage, Lux Meter, Turbidity meter, Siltmeter, Anemometer and Psychrometer - Familiarization of hydrographic tools - Collection of environmental data – collection of sea water using oceanographic samplers.

Preparation of ocean parameter distribution maps: vertical profile and sections, horizontal sections – T-S diagrams and water mass identification – coastal upwelling using temperature sections – sea level data analysis.

II SEMESTER

OCE 2201 OCEAN DYNAMICS (CORE) Credit : 4

Unit I

Statics of the ocean: fields of gravity, pressure and mass, barotropic and baroclinic fields, quasi static conditions, sigma-t surfaces, static stability, double diffusion, kinematics – field of motion, representation of field of motion in the sea, equation of continuity. Equation of motion, non-linear terms in the equation of motion, equation of mean flow, Reynold's stress and eddy viscosity, scaling equation of motion, dynamic stability.

Unit II

Currents without friction, inertial motion, Margules's equation for a two layer ocean, geostrophic current, relative current and slope current, Hellan-Hansen's formula, thermal wind equations, level of no motion and absolute currents. Homogeneous geostrophic flows over an irregular bottom – Generalization to non-geostrophic flows. Quasi-Geostrophic Dynamics- Simplifying assumptions- Governing Equations.- Planetary waves in a stratified field – non-linear effects

Unit III

Currents with friction, Ekman's solution to the equation of motion with friction, drag co-efficient, Ekman transport and upwelling, bottom friction and shallow water effect, Sverdrup's equation and its application, equatorial undercurrent, Stommel's and Munk's theorem, westward intensification of ocean current.

Unit IV

Barotropic Instability- waves on a shear flow- Bounds on wave speeds and growth rates. Baroclinic Instability – cause for instability – linear theory

References:

1. The Oceans, H U Svedrup et al., Prentice Hall, 1946.
2. Physical Oceanography, A. Defant, Vol-1, New York Pergamon Press, 1961.
3. Principles of Physical Oceanography, W J Pierson and G Neumann, Prentice-Hall and Englewood Cliffs, 1966.

4. Dynamical Oceanography: J. Proudman, Methuen & Co. Ltd, 1963
5. Introductory Dynamic Oceanography: S Pond & G L Pickard, 2nd Edn. Pergamon, 1983.
6. General Oceanography, G Dietrich, Wiley-Interscience, 1963
7. The Sea, M N Hill, Vol-1, Interscience Publishers, 1966
8. Introduction to Physical Oceanography, W S von Arx, Addison-Wesley, 1967.
9. The Dynamic Method in Oceanography, L M Fomin, Elsevier Applied Science, 1964.
10. Oceanography for Meteorologists, H U Sverdrup, Biotech Books, 2002.
11. Ocean Currents, G Neumann, Elsevier Publishing Company, 1968.
12. Introduction to Geophysical Fluid Dynamics, Cushman Rosetin, 1st Edn, Prentice Hall, 1994.

OCE 2202 WAVES AND TIDES (CORE) Credit : 3

Unit I

Introduction to wave motion. Hydrodynamic equations. Boundary conditions. Equation of wave motion. Small amplitude waves – Phase speed, particle velocity, particle displacement, wave pressure, standing waves. Group velocity. Wave energy. Shallow water wave transformation - Internal waves. Capillary waves.

Unit II

Finite amplitude waves: Gerstner's wave – phase speed, vorticity, surface profile correct to third order. Stokes wave – Surface profile correct to third order, phase speed, Stoke's drift. Crapper's wave. Cnoidal wave. Solitary wave.

Characteristics of wind waves and swells. Significant wave height and period. Wave spectrum. Wave generation - Fetch limited, duration limited and wind speed limited conditions. Theories of wave generation. Wave prediction – SMB and PNJ methods.

Unit III

Phase speed of a long wave. Gyroscopic gravity waves. Kelvin waves. Rossby waves. Tsunamis. Storm surges. Seiches. Ocean tides - tide generating forces. Theories of tide. Tide analysis and prediction. Harmonic analysis and fourier spectrum analysis - Tides in typical ocean regions. Amphidromic points – Tidal bores and tidal currents.

References:

1. Wind Waves- Their Generation and Propagation on the Ocean Surface: B. Kinsman, Dover, 1984
2. Physical Oceanography, Vol. II: A. Defant, Pergamon Press, 1961
3. Introductory Dynamical Oceanography: S. Pond and G. L. Pickard, 2nd edition, Elsevier, 1983
4. Waves : C. A. Coulson, Butler Press, 2007
5. Estuary and Coastline Hydrodynamics: A. T. Ippen, Iowa State University Press, 1982
6. Principles of Physical Oceanography: W. J. Pierson and G. Neumann, Prentice-Hall, Fifth edition, 1966
7. The Oceans- their physics, chemistry and general biology: H. U. Sverdrup et al., Prentice-Hall, first edition, 1942
8. Oceanographical Engineering: R. L. Weigel, Prentice-Hall, 1964
9. Dynamical Oceanography: J. Proudman, Methuen, 1953
10. Admiralty Manual of Tides: A. T. Doodson and H. D. Warbin, H.M. Stationery Office, 1941
11. The Tides: G. H. Darwin, W.H.Freeman and Co, 1962

12. Hydrodynamics: H. Lamb, Dover Publications; 6 edition, 1945
13. Practical Methods for Observing and Forecasting Ocean Waves by Means of Wave Spectra and Statistics: W. J. Pierson, Hydrographic Office, 1955
14. Tides, Surges and Mean Sea Level: D. T. Pugh, John Wiley & Sons Ltd., 1996
15. The Indian Ocean Tsunami: T. S. Murty, U. Aswathanarayana, N. Nirupama, Taylor & Francis, Inc. 2006

OCE 2203 COASTAL AND ESTUARINE OCEANOGRAPHY (CORE) Credit : 4

Unit I

Sea Coasts and shorelines, shoreline features, Coastal processes, factors influencing coastal processes. Beaches – types and features, beach configuration & profiles, beach erosion & accretion, long shore bars, sand spits, atolls, beach stability.

Unit II

Wave transformation in shallow waters, effect of bottom friction, phenomena of wave reflection, refraction and diffraction, breakers, littoral currents. Sediment transport in coastal zone, wave action on sediments, alongshore and cross shore transport, rate of sediment transport, artificial nourishment.

Unit III

Coastal zone management, ICZM, environmental characteristics and conditions, Matrix approach, oceanographic aspects in coastal zone protection, coastal zone of India.

Unit IV

General characteristics of estuaries, classification and nomenclature, estuaries as part of river – coastal – near shore continuum, stratification, estuarine circulation and mixing, tidal prism, entrainment, sedimentation in estuaries, uses and issues associated with estuaries.

References:

1. Oceanography for beginners: Pranab K Banerjee, Allied Pub., 2005
2. Sea Level Rise, Coastal Engineering, Shoreline and tides: Oceanography and Ocean Engineering: Wright Linda L., Nova Science Pub., 2011
3. Coastal Oceanography: Yanagi Tetsuo, Kulwer, 1999
4. Beaches Processes and Sedimentation: P D Komar, Prentice Hall, 2nd edn., 1997
5. Integrated Coastal and Ocean Management: Cicin-Sain & Knecht, Island Press, 1998
6. Beaches and Coasts: C A M King, Edward Arnold, 1961
7. Shelf Sediment Transport Processes and Pattern: D J P Swift, Dowden Hutchinson & Ross, 1973
8. Oceanographical Engineering: R L Wiegel, Dover Pub., 2005
9. Coastal Zone Management: D R Green, Thomas Telford Pub., 2009
10. Beaches and Coasts: R A Davis & D M Fitzgerald, Wiley Blackwell, 2004
11. Mechanics of Coastal Sediment Transport: Adv. Series in Ocean Engineering: J Fredsoe & R. Deigaard, Vol. 3 , World Scientific Publishing Company,1992.
12. A Guide to Modeling Coastal Morphology: Adv. in Coastal & Ocean Engineering, D Roelvink & A Reniers, Vol -12, WSPC, 2011
13. GIS in Oceanography and Fisheries: D Vasilis & Valavanis, Taylor and Francis,2002
14. Geomorphology and Sedimentology of Estuaries: Perillo, G M E, Elsevier,1996
15. Estuaries- Monitoring & Modeling the Physical System: Jack Hardisty, Blackwell, 2007
16. Estuarine Ecohydrology: Eric Wolanski, Elsevier, 2007
17. Estuary and Coastline Hydrodynamics: A T Ippen, McGraw Hill, 1966

18. Estuaries: A Physical Introduction: K R Dyer, John Wiley, 1973
19. Estuaries: G H Lauff, AAAS, 1967
20. Coastal Wetlands : An Integrated Ecosystem Approach: Perillo G M E, Elsevier, 2009

OCE 2204 DYNAMICAL COMPUTATIONS – I (Practical) (CORE) Credit : 1

Thermal structure, Static Stability, Specific volume anomaly, Dynamic depth, Relative currents, Level of No motion, Absolute currents, Divergence and convergence, Ekman spiral, Mass transport, Upwelling

OCE 2205 COASTAL OCEANOGRAPHY (Practical) (CORE) Credit : 2

Preparation and interpretation of Bathymetric charts, Beach Profiles, Preparation of wave refraction diagrams, Estimation of littoral wave conditions, Littoral drift and sand budget, Analysis of wave records, Hind casting of ocean waves.

OCE 2206 OCEANOGRAPHIC APPLICATION TOOLS (Practical) (CORE) Credit : 1

Computational mathematical software and its applications – OCTAVE - Numerical methods– graphical software and its applications – data analysis.

III SEMESTER

OCE 2301 OCEAN REMOTE SENSING (CORE) Credit : 4

Unit I

Introduction to Remote Sensing: Basic concepts – Electromagnetic radiation – solar and terrestrial radiation, atmospheric effects absorption, transmission and scattering. Spectral response of Earth's surface features. – Atmospheric windows –concept of spectral signature. Remote sensing platforms: Near polar, geostationary and sun synchronous satellites.

Unit II

Sensors: swath, spatial, temporal, spectral and radiometric resolution- Active and passive remote sensing– Remote Sensing in Indian perspective- Indian Satellites and sensors for oceanographic applications. Basics of satellite image processing.

Unit III

Visible remote sensing: theory of ocean colour remote sensing optical properties of pure water, natural waters and atmosphere – optical pathways in the atmosphere – – Scattering and absorption of light – colour of the sea: phytoplankton, yellow substance, suspended particulate matter principle of estimation and its applications– case 1 and case 2 waters – satellite sensors for ocean colour data.

Unit IV

Infrared Remote Sensing:thermal emission – atmospheric absorption – SST retrieval –atmospheric correction – effect of cloud – thermal skin layer – skin and bulk SST effect of surface films – Infrared radiometers -NASA pathfinder, global SST data: SST – applications. Satellite and sensors for measurement of SST- LIDAR & shallow bathymetry.

Unit V

Microwave Remote Sensing: Microwave emission of sea surface – atmospheric effects –Microwave bands, sensors – passive and active microwave radiometers – retrieval of salinity , ocean waves, SST, Sea ice, oil spills. Scatterometers: –wind and radar backscatter – wind speed and direction. Altimetry: principles –sea surface height anomaly –Currents, SSH, Planetary waves-ERS, T/P, Jason1, SARAL –applications.

References:

1. Remote Sensing of the Changing Oceans, Dan Ling Tang, Gad Levy, Malcolm Heron, James Gower, Kristina B. Katsaros and Ramesh Singh, Springer;2011
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. Measuring the Oceans from Space: The Principles and Methods of Satellite Oceanography: I. S. Robinson, 2004, Praxis Publishing, UK
5. Oceanographic Applications of Remote Sensing: Motoyoshi Ikeda and W. Dobson CRC Press, 1995.
6. Application of Remote Sensing Technology to Marine Fisheries. An Introductory Manual: Fisheries, M.J.A.Butler, M.C.Mouchot, V.Barale and Lebanc.C, 1988, Technical Papers, FAO publications, Vol.295
7. Satellite Oceanography: An Introduction for Oceanographers and Remote Sensing Scientists: I.S. Robinson, Ellis Horwood ,1985
8. Methods of Satellite Oceanography: Robert H. Stewart ,1985 Publisher: Berkeley, California.
9. Satellite Microwave Remote Sensing : T.D. Allan , Ellis Horwood Series in Marine Science, Chichester. 1983
10. Introduction to Satellite Oceanography: G.A. Maul , Springer; 1985 edition

OCE 2302 OCEAN MODELING (CORE) Credit : 4

Unit I

Introduction, type, advantage and limitations of models – Fundamental laws-governing equations; basic balance equations for mass, momentum, energy, heat and salt – equation of state - approximations and representations - boundary conditions.

Unit II

Development of models - finite difference methods – Taylor's series - advection equation – CFL criteria - numerical diffusion - computation errors - Implicit and explicit finite difference schemes – leap frog scheme – trapezoidal implicit scheme – Crank-Nicolson schemes - stability criteria- computational instability- finite element methods.

Unit III

Concepts of models - modeling of ocean processes – reduced gravity model - various types of grids - computation of time step for integration- physical processes involved in modeling of upper ocean -barotropic and baroclinic instabilities – spin up - Cox's model of Indian Ocean.

Unit IV

OGC Models - POM, MOM and ROMS models. Components and processes – Ocean-atmosphere coupled models. Data inputs – interpretations. Introduction to model validation, Calibration and Data assimilation – hindcast, nowcast, forecast and prediction – application to ENSO.

References:

1. Introductory Dynamical Oceanography: Stephen Pond & George L. Picard, 1986, 329p.
2. Modeling Marine Processes: Phil Dyke, Prentice Hall,1996, 152p
3. Computer Modeling in Atmospheric and Oceanic Sciences: Peter Muller and Hans Von Storch, springer, 2004, 304p
4. Numerical Modelling of Oceans and Oceanic Processes: Lakshmi H.Kantha & Carol Anne Claysor,Academic Press, 2000,943p
5. Ocean Modelling for Beginners using Open Source Software: Jochen Kampf, Springer, 2007, 173p
6. Dynamics & Modelling of Ocean Waves, Komen et al., Cambridge University Press,1994, 532p
7. Introduction to the Modeling of Marine Eco-systems: W. Fennel & T. Newmann, Elsivier, 2004
8. Numerical Modeling of Ocean Dynamics: Z Kowalik & T. S. Murthy, World Scientific, 1995.
9. Modeling and Prediction of the Upper Layer of the Ocean: E B Kraus, Pergman Press,1977, 325 p
10. Ocean Circulation Physics: M E Stern, Academic Press, 1975, 246p
11. Numerical Modeling of Marine Hydrodynamics – Application to Dynamic Physical Processes: H G Ramming & Z Kowalik, Elsevier,1980.
12. Numerical Prediction and Dynamic Meteorology: Haltiner, George J., and Roger T. Williams., 2nd Ed., Hoboken, NJ: John Wiley & Sons, 1980.
13. Numerical Ocean Circulation Modeling. Haidvogel, Dale B. and Aike Beckmann.. River Edge, N J, Imperial College Press,1999, 318p.
14. Ocean Circulation and Climate: Observing and Modelling the Global Ocean: Gerold Sielder, John church and Jon Gould, International Geophysical Series, Vol. 77, Academic Press, 2001,715p
15. Coupled Ocean Atmosphere Models: Nihoul, J C J., Elsevier 1985

OCE 2303 AIR SEA INTERACTION (CORE) Credit : 4

Unit I

Atmospheric turbulence**:** Introduction - atmospheric surface layer - general characteristics of turbulence - turbulent fluxes of momentum, water vapour and heat – turbulence spectrum - fundamental hypothesis and theories of turbulence - turbulent kinetic energy (TKE) - Richardson number – Reynolds equations – Reynolds stress and friction velocity - K theory and eddy viscosity - mixing length theory

Unit II

Small scale interaction: Similarity theory for a neutral atmosphere - surface roughness - logarithmic wind profile – Monin-Obukhov similarity theory - similarity functions - bulk-aerodynamic formulation of fluxes – bulk exchange coefficients - methods of flux measurements - air-sea gas exchange –

Unit III

Large scale interaction: **O**cean-atmosphere system - shortwave solar radiation - longwave terrestrial radiation – radiation balance - latent and sensible heat fluxes – global and regional ocean heat budget - flux measurements using satellites – estimation of heat transport – evaporation and precipitation - freshwater budget – wind stress over the ocean

Unit IV

Air-sea interaction and climate: ocean and climate – interannual variations in heat transport – long term trends – large-scale anomalies: ENSO, North Atlantic Oscillation (NOA), Indian Dipole mode (IOD), Pacific Decadal Oscillation (PDO) – sea spray and climate

References:

1. Wind Stress over the Oceans, Ian S. F. Jones and Y. Toba, Cambridge University Press, 2009.
2. Ocean-Atmosphere Interactions, Yoshiaki Toba, Terra Scientific Publishing Company, 2003.
3. Introduction to Micrometeorology, S. Pal Arya, Academic Press, 2001
4. Air-Sea Exchange: Physics, Chemistry and Dynamics, G. L. Geernaert, Kluwer Academic Publishers, 1999.
5. The Oceans and Climate, Grant R. Bigg, Cambridge University Press, 1996.
6. Atmosphere-Ocean Interaction, E. B. Kraus and J. A. Businger, Oxford University Press, 1994.
7. Introduction to Boundary Layer Meteorology, R. B. Stull, Kluwer Academic Publishers, 1988.

OCE 2304 LARGE SCALE OCEAN PROCESSES (Practical) (CORE) Credit : 2

Hydrography: Levitus climatology of temperature and salinity – estimation of ocean mixed layer depth and climatology – T-S diagram and water mass analysis

Ocean heat budget: Computation of latent and sensible heat fluxes using bulk formula – radiation budget – heat budget using OAFlux data – interannual variations in heat balance – heat transport

Ocean circulation: seasonal wind pattern over Indian Ocean – wind stress distribution – ocean circulation using SODA data - processing drifting buoy data

Interannual variability: ENSO - Southern Oscillation index – Pacific Ocean warm pool variability – Nino index – Indian Ocean Dipole Mode (IOD) -

OCE 2305 OCEAN MODELING (Practical) (CORE) Credit : 1

Numerical differentiation and Numerical integration - Numerical solution of partial differential equations

Mathematical models – equations - Computation of suspended and bed load sediment transport

Numerical models – Discretization of governing equations using various schemes – Advection and Diffusion

Forecast of various oceanic parameter using Governing equations – Buoyancy – Inertial currents – Ekman Currents

Familiarization of Princeton Ocean Model (POM) and Regional Ocean modeling system (ROMS) - Presentation and interpretation of model results

IV SEMESTER

OCE 2401 PROJECT DISSERTATION (CORE) Credit : 16

OCE E201 GENERAL OCEANOGRAPHY (ELECTIVE) Credit : 2

Unit I

General introduction - dimension of oceans - geographical features - physical properties of sea water and its measurement - distribution of temperature, salinity, density and oxygen in space and time

Unit II

Water masses: formation and classification - T-S diagram - water masses of the world ocean with special reference to Indian Ocean – Heat budget of ocean - insolation – long wave radiation – effect of clouds – sensible and latent heat transfer- Bowen's ratio.

Unit III

Circulation: general circulation of the atmosphere – trade winds – wind-driven and thermohaline circulation - major currents of the world oceans – seasonal currents in the Indian ocean - upwelling and sinking with special reference to the Indian Ocean. El-Nino and La-Nina.

References:

1. Descriptive Physical Oceanography, An Introduction: G. L. Pickard and W. J. Emery, Pergamon, 5th edn., 1992.
2. Descriptive Physical Oceanography, Reddy, M. P. M., New Delhi Oxford & IBH, 2000.
3. The Oceans- Their physics, chemistry and general biology, H U Sverdrup, Prentice Hall, 1942.
4. Principles of Physical Oceanography, W J Pierson and G Neumann, Prentice-Hall and Englewood Cliffs,1966.
5. General Oceanography, G Dietrich, Wiley-Interscience, 1963.

OCE E202 MARINE HAZARDS AND MANAGEMENT (ELECTIVE) Credit : 2

Unit I

General introduction – Classification - overview of marine and atmospheric hazards – Tsunami- Cyclones - storm surges – floods - coastal vulnerability - shore line changes - landslides – earthquakes

Unit II

Pollution - oil spills - chemical and other pollutants – toxic algal bloom - thermal pollution – radioactivity - remedial approaches – dredging – mining - sand excavation - structures and ship collision – fire on oil rigs

Unit III
Winds, waves, currents as agencies bring about hazards - Hazard management -Mitigation measures - long term planning – pre hazard action plans - hazard monitoring and early warning systems – active post hazard management plans

References:

1. Global Warming-The Complete Briefing: H. John, 4th Edn, Cambridge University Press, 2009.
2. Ocean Environmental Management: E. G. Frankel, 1st Edn, Prentice Hall, 1995.
3. Encyclopedia of Disaster Management: P. C. Sinha, Anmol, India, 2002.
4. Environmental Hazards-Assessing Risk and Reducing Disasters: K. Smith, 5th Edn, Routledge, 2009.
5. Global Environmental Change: Past, Present and Future: Karl K. Turekian, Prentice Hall; 1 edition, 1996

OCE E203 MARINE POLLUTION (ELECTIVE) Credit : 3

Unit I
Pollution of the marine environment, marine pollutants and their sources. Types of pollutants – inorganic, organic, biological, thermal, radioactive and non-point.

Unit II
Marine factors involved in transport & dispersal of pollutants - the transport phenomenon, advective and diffusion aspects. Dispersal of pollutants in estuaries and near shore areas, physical oceanographic factors affecting marine pollution.

Unit III
Impacts of pollution on the oceans. Control and abatement of marine pollution, oil pollution, oil slicks and their management- chemical dispersants, containment of oil at sea. Coral bleaching. Indian scenarios and case studies. Monitoring strategies, water quality parameters and standards, hazardous material transport, open ocean dumping and incineration, monitoring and control, general laws on prevention on marine pollution.

References:

1. Remote Sensing for the control of Marine Pollution: Jean Marie Massin, Springer, 1984
2. Marine Environment Pollution: R A Geyer, Elsevier, 2000
3. Water and Water Pollution: L L Ciaccio, Marcel Dekker,1971
4. Dispersion in Estuaries and Coastal Waters: R Lewis, Wiley, 1997
5. Oceanic Processes in Marine Pollution: JM Capuzzo & Kester,Krieger, 1987
6. Marine Pollution: R B Clark, Oxford Uty Press, 2001
7. Marine Pollution : New Research: T N Hofer et al., Nova Science, 2008
8. Marine Pollution & Human Health: R E Hester, Royal Soc. Chem., 2011
9. Coastal Pollution: C J Sindermann, CRC Press, 2005
10. Oil Spill Response in the Marine Environment: J W Doerffer, Pergamon Press, 1992
11. Wastewater Engineering: Metcalf & Eddy, McGraw-Hill, 1979
12. Metal Pollution in the Aquatic Environment: U Forstner & Wittmann,.W. Springer-Verlag, 1979
13. MARPOL 73/78 Consolidated Edn, 1991: International Maritime Organization, 1992

OCE E204 OCEAN OPTICS (ELECTIVE) Credit : 2

Unit I

Introduction – Characterization of light field in water, radiance, irradiance, diffuse attenuation coefficient, water leaving radiance – Inherent and Apparent optical properties of sea water – Light scattering by water molecules – Raman scattering by water – Rayleigh scattering Mie scattering –

Unit II

Absorption characteristics of water constituents - Backscattering characteristics of water constituents – Fluorescence by phytoplankton and Dissolved Organic matter – Impact of bottom refection on upwelling radiance and volume reflectance in water – Colour of the sea. Optical properties of Case I and Case II waters-Refractive index of sea water-Remote sensing reflectance, reflectance albedo, Photo-synthetically Active Radiation.

Unit III

Hydro optical models-Bio-optical models, Composition of natural water and its relation to hydro-optics, Ocean colour remote sensing – Ocean colour sensors, Algorithms for Ocean colour data processing, Ocean colour application studies - Underwater photography and Imaging instruments.

References:

1. Marine Optics: N. G. Jerlov, Elsevier, 2nd edition, 1976
2. Physical Optics of Ocean Waters: K. S. Shifrin, Springer, 1983
3. Colour of Inland and Coastal waters - A methodology for its interpretation: Dimitry Pozdnyakov and Hartmut, Springer with Praxis Publishing, UK, 2003

OCE E205 MARINE ACOUSTICS (ELECTIVE) Credit : 4

Unit I

Introduction to Ocean acoustics. Acoustic plane, spherical and cylindrical wave equations and their solutions. Sound velocity in fluids. Energy density . Acoustic intensity. Acoustic standards. The decibel scale.

Unit II

Reflection and transmission of plane waves: Normal incidence; fluid – fluid interface, fluid-solid interface, standing wave patterns, transmission through three media. Oblique incidence; fluid-fluid interface, angle of intromission, fluid-solid interface.

Unit III

Absorption of sound waves in fluids. Sound transmission loss in sea water. Sound velocity structure of the sea. Ray tracing. Refraction phenomenon. Sound channels. Surface and bottom reflections. Sound transmission in shallow water – ray and normal mode solutions. Attenuation in inhomogeneous fluids. Scattering from non-resonant bodies and bubbles. Bubble resonance. Scattering characteristics of marine life – non-resonant bodies, resonant swim bladder of fish.

Unit IV

Piezoelectric and magnetostrictive sonar transmitting and receiving transducers. Hydrophones. Radiation pattern of sonar transducers – array of discrete and continuously distributed source elements. Transmitting and receiving directivity factor and directivity index. Beam shaping

for arrays.

Unit V

Active sonar signals, resolution and bandwidth: Source level, echo level. Masking by noise and reverberation. Improving signal-to-noise ratio. Additional parameters significant in active sonar. Echo sounding and sub bottom profiling. Diffraction of impulsive signal at rough surfaces. Average reflection coefficient for rough surfaces. Doppler effect of moving objects. Doppler navigation. Passive sonar: Fundamental characteristics. Acoustic output of ships. Passive detection range. Passive detection hydrophones. Array steering. Ocean acoustic tomography.

References:

1. Fundamentals of Acoustics: L. E. Kinsler and A. R. Frey, Wiley; 4th edition, 1999
2. Acoustical Oceanography- Principles and Applications: Clay and Medwin, Wiley, 1977
3. Underwater Observation Using Sonar: D. G. Tucker, Fishing News (Books), 1966
4. Underwater Acoustics: Leon Camp, Wiley- Interscience, 1970
5. Applied Underwater Acoustics: D. G. Tucker and B. K. Gazey, Pergamon Press,1966
6. Introduction to the Theory of Sound Transmission: C. B. Officer, McGraw-Hill, 1958
7. Principles of Underwater Sound for Engineers: R. J. Urik, McGraw-Hill Ryerson,1983
8. Ocean Acoustics- Theory and Experiment in Underwater Sound: Tolstoy and Clay, Acoustical Society of Amer, 1987
9. Ocean Acoustic Tomography- A Scheme for Large Scale Monitoring: Munk, W. and C. Wunsch, Deep Sea Res., 26A, PP. 123-161, 1979
10. A Demonstration of Ocean Acoustic Tomography- The Ocean Tomography Group Nature, 299, PP. 121-125, 1982

OCE E206 COASTAL ZONE MANAGEMENT - I (ELECTIVE) Credit : 3

Unit I

Concepts, definition and approach – general classification of coastal zones of the World – dominant natural processes - Asia –Pacific coastal zone - State of the environment – terrestrial and marine influence on coastal zone – catchment coast interactions.

Unit II

Coastal resources and utilization – conservation measures – developmental activities – human pressures and responses – hotspot management – hazards and vulnerability analysis. Management options - DPSIR - Matrix approach - participatory dialogues and stakeholder roles – voluntary partnerships - integrated management and planning – sustainable development.

Unit III

Legal Regime – law of the sea - territorial sea and EEZ – Indian coastal policy – implementation of policy – traditional practices and modern engineering innovation.

References:

1. Fluvial Processes and Environmental Changes: A. Brown, T. Quine, Wiley; 1 edition, 1999
2. Perspectives on Integrated CZM: W. Salomons, R. K. Turner, Lacerda, L.D. de, S. Ramachandran, Springer, 1999
3. CZM handbook: R. J. Clark, CRC Press; 1 edition, 1995
4. Coastal Zone Management: Korakandy, Kalpaz Publications, 1st edn., 2005
5. Coastal Wetlands : an integrated ecosystem approach: Perillo G M E, Elsevier, 2009
6. Integrated CZM: Erland M, Wiley – Blackwell, 2009
7. Sustainable Coastal Management & Climate Adaptation: R Kenchington, CRC Press, 2012

OCE E207 COASTAL ZONE MANAGEMENT – II (ELECTIVE) Credit : 3

Unit I

Global environmental change - climate change and impacts on coastal zone – sea level changes and coastal responses – approaches to sustainable coastal zone management – adaptive management in contextual scenarios.

Unit II

Coastal surveying methods – monitoring - approach to field work - sampling techniques - RS/GIS applications – EIA within the framework of CZM. Coastal engineering works – structures – impacts - shore protection and maintenance -dredging and impacts - ports and harbours - pre-requisites

Unit III

Marine spatial planning and ICZM – concepts and application – coastal and marine spatial data – zoning and uses of coastal zone based on GIS and MSP.

References:

1. Advances in Coastal and Ocean Engineering: Philip L. F. Liu, World Scientific Pub Co Inc., 1997
2. Statistical Data Analysis for Ocean and Atmospheric Services: H. J. Thiebaux, Academic Press, 1 edition, 1994
3. Perspectives on Integrated CZM: W. Salomons, R. K. Turner, Lacerda, L.D. de, S. Ramachandran, Springer, 1999
4. Coastal Erosion, Response and Management: C. H. Roger and C. P. De Meyer, Springer; 1998
5. CZM Handbook: R. J. Clark, Taylor & Francis, 1995
6. Port Engineering: G. Tsinker, John Wiley & Sons, 2004
7. Coastal Engineering Manual- Part I: Introduction, with Appendix A: Glossary of Coastal Terminology, U.S. Army Corps Of Engineers, Books Express Publishing, 2012
8. Coastal Wetlands : An Integrated Ecosystem Approach: Perillo G M E, Elsevier, 2009
9. Integrated CZM: Erland M, Wiley – Blackwell, 2009
10. Sustainable Coastal Management & Climate Adaptation: R Kenchington, CRC Press, 2012.

OCE E208 BEACH DYNAMICS (ELECTIVE) Credit : 2

Unit I

Beach features and classification – Beach cycles – Beach profiles – Erosion and Accretion- Beach Dimensions – Two dimensional beaches – Surf zone – Swash zone – Three dimensional beaches – Beach Quantification – Beach morphodynamics – coastal processes and shore face equilibrium- Coastline changes- Case study.

Unit II

Coastal boundaries – Beach Sediments – Sediment budget - Global changes in coastal sediments – Bar formation- Barrier beach formation -Wave climate – Surf zone – Waves generation- Wave transformation and wave set up – Wave transformation models Longshore currents – Rip currents – Onshore- Offshore sediment transport- Sediment transport models.

References:

1. Beaches and Coasts: C A M King, Edward Arnold, 1961
2. The Coastline: R S K Barnes, Wiley-Blackwell, 1977
3. Waves on beaches: R E Mayer, Academic Press, New York, 1972
4. Coasts – An Introduction to Coastal Geomorphology: C F Bird, Blackwell Pub; 3 Sub edition, 1984
5. Coastal Sedimentary Environments: R A Davies, Springer; 2nd ed. 1985 edition, 2011
6. Coastal Environments- An Introduction to the Physical, Ecological, and Cultural Systems of Coastlines: R W L Carter, Academic Press, 1989

OCE E209 GIS IN OCEANOGRAPHY (ELECTIVE) Credit : 2

Unit I

Introduction to Geographical Information System (GIS) – data and analysis techniques – hardware and software – general applications. The Marine Geographic Information Systems – uses in various fields of oceanography – Data sampling – identification of ocean features – mapping seabed – GIS tools in fisheries

Unit II

GIS and Coastal Zone – Planning in CZ – data analysis and applications using GIS – managing CZ resources – GIS as a decision support system

References:

1. Managing Geographic Information System Projects: W. E Huxhold & A G Levinsohn, Oxford University Press, 1995
2. Coastal and Marine Geo Information Systems: D R Green & S D King, Springer, 1st ed. 2003
3. Geographic Information Systems in Oceanography and Fisheries: V D Valavanis, CRC Press, 2003
4. Wetland and Environmental Application of GIS: JGLyon & J MaCarthy, Lewis Pub. 1995
5. An Introduction to GIS: I Heywood, S Cornelius& S Carver, Prentice Hall; 2 edition, 2002
6. GIS & Science: P. A.Longley, MF Goodchild, D J Maguire & D W Rhind, Wiley; 3 edition, 2010
7. GIS – An Introduction: T Bernhardsen, Wiley; 3 edition, 2002

8. Integration of GIS and RS: J L Star, J E Estes and K C, McGwire, Cambridge University Press, 1997
9. GIS & Multi Criteria Decision Making: J Malczewski, John Wiley & Sons, 1999
10. Spatial Models and GIS New Potential and New Modes (GIS DATA): I Masser, F Salge, A S Fotheringham & M Wegner, CRC Press; 1 edition, 1999
11. Innovations in GIS 5: S Carver, Taylor and Francis, 1998

OCE E210 COMPUTER PROGRAMMING IN OCEANOGRAPHY (Practical) (ELECTIVE) Credit : 2

Variables, data and types, assignment statements, arithmetic statements, input and output statements, FORMAT and pause statements

DO Loop, nested and implied DO loop, IF statement, nested block IF, computed GOTO statements - Subscripted variables (arrays) - single and multidimensional arrays.

User-defined functions and subroutines - nesting of subprograms, COMMON and EQUIVALENCE statements - file operations - reading from and writing to files – multiple file operations

Oceanographic applications – processing profile data – quality control of temperature and salinity data – interpolation – horizontal and vertical averages – processing time-series and global data.

OCE E211 COMPUTER PROGRAMMING IN C (Practical) (ELECTIVE) Credit : 2

Fundamentals of C Programming: Data types – operators and expressions – control constructs – if statement - for and while loops - Arrays – functions

Control constructs – do-while, switch statements – break and continue – exit function – argc and argv.

Pointer – dynamic allocation of functions – structures – array of structures – file operations – fopen, fclose, putc, getc and fprintf, fscanf functions.

OCE E212 ESTUARINE SEDIMENT DYNAMICS (ELECTIVE) Credit : 2

Unit I

Sedimentary Environments– Physical properties of sediment and fluids- dynamics and kinematics of flow, particle flow through fluids, Newtonian flow around a sphere- particle size characteristics, settling velocity.

Unit II

Erosion and sedimentation, mechanics of bed forms, Bed form classification and Geometry. Basic concepts of sediment transport, suspended and bed load transport, mathematical approach, total load transport; transport capacity. Short term and long term sediment loads, field measurements, computation of sediment transport.

Unit III

Estuarine sedimentation- sediment input to an estuary- estuarine sediment transport processes,

flocculation and sedimentation in estuarine harbour areas, sediment control methods.

References:

1. Erosion and Sedimentation: P. Y. Julian, Cambridge University Press, 1998
2. Dynamics of Marine Sands- A Manual for Practical Applications: Soulsby, Thomas Telford, 1997
3. Mechanics of Coastal Sediment Transport: Adv. Series in Ocean Engineering: J Fredsoe & R. Deigaard, Vol. 3 , World Scientific Publishing Company,1992.
4. Physics of Estuaries and Coastal Seas: J. Dronkers and M.B.A.M. Scheffers, Taylor & Francis; 1 edition, 1998
5. Estuaries: A Physical Introduction: K R Dyer, John Wiley, 1973
6. Estuarine Hydrography and Sedimentation: K. R. Dyer, Cambridge University Press, 1979

OCE E213 OCEAN CIRCULATION (ELECTIVE) Credit : 2

Unit I

Theories of wind-driven circulation, Sverdrup solution, frictional and inertial boundary regimes; instabilities, meanders and meso-scale features; role of stratification, topography and time dependence;

Unit II

Thermohaline circulation- Conveyor belt- Formation and distribution of water masses-subduction and ventilation- Abyssal circulation- mixing – Isopycnal and diapycnal mixing -Topographic steering, thermodynamic and salinity circulation, equations for salt and temperature conservation, Reynold's fluxes and eddy diffusivity, thermocline and thermohaline circulation, mixed layer of the ocean.

References:

1. The Oceans- Their physics, chemistry and general biology: H. U. Sverdrup et al., Prentice-Hall, first edition, 1942
2. Physical Oceanography: A. Defant, Vol-1, New York Pergamon Press, 1961
3. Principles of Physical Oceanography: W J Pierson and G Neumann, Prentice Hall, 1966.
4. Dynamical Oceanography: J. Proudman, Methuen, 1953
5. Introductory Dynamic Oceanography: S Pond & G L Pickard, 2nd Edn. Pergamon, 1983.
6. General Oceanography: G Dietrich, Wiley-Interscience, 1963.
7. The Sea: M N Hill, Vol-1, Interscience Publishers, 1966
8. Introduction to Physical Oceanography: W. S. Von Arx, (1st ed.), 1962
9. The Dynamic Method in Oceanography: L M Fomin, Elsevier Applied Science, 1964.

OCE E214 REMOTE SENSING APPLICATIONS (Practical) (ELECTIVE) Credit : 2

Digital Image processing: Geometric correction of satellite data, Image georeferencing and registration, othorectification of images, Radiometric correction techniques. ratioing, enhancement and application of spatial filters , transformations, colour display techniques, Classification methods: supervised and unsupervised classification techniques for coastal

zone. Data: OCM, MODIS-Ocean color; MODIS, NOAA-SST, IRS-LISS-3 coastal habitat.

Applications: chlorophyll, suspended sediments and yellow substance (CDOM), generation of imageries and interpretation. Coastal habitat identification and assessment. Softwares: SeaDAS, ENVI , IDRISI and ERDASIMAGINE .

OCE E215 DYNAMICAL COMPUTATIONS – II (Practical)
(ELECTIVE) Credit : 2

Representation of oceanic motion, Dynamic topography, Identification of mesoscale structures – fronts, eddies, Watermass identification, Isopycnal analysis, Computation of potential vorticity Stability analysis.

OCE E216 MARINE REMOTE SENSING APPLICATIONS
(ELECTIVE) Credit : 4

Unit I

Introduction to Remote Sensing – Basic concepts – electromagnetic radiation – solar and terrestrial radiation – atmospheric effects – absorption, transmission and scattering – atmospheric windows – spectral signature. Basics of satellite image processing. Remote sensing application to marine fisheries: LIDAR, Bioluminescence, LLLTV-aerial survey for fish finding, SST and Potential Fishing Zone from NOAA-AVHRR. Global food chain from chlorophyll – SeaWiFS applications.

Unit II

Remote sensing application to Marine Biology: Chlorophyll and biological production from remote sensing. Yellow substance – Oceansat-OCM. Band descriptions of OCM & Sea WiFS for biological studies. Mangroves, Sea grass, coral reefs identification – IRS-SPOT-LANDSAT applications.

Unit III

Remote sensing application to Marine Geology: studies on erosion, accretion, suspended sediment concentration, wetland mapping, shoreline changes. IRS, LANDSAT, CARTOSAT, SPOT applications.

Unit IV

Remote sensing applications to chemical Oceanography: Oil slicks on the Ocean surface-SAR imagery. Water quality studies. Remote Sensing applications to Meteorology – Global Ozone quantities, SO_2 in the atmosphere, TOMS applications. Clouds, Total Precipitable Water – SMMR, TRMM, Weather forecasting. Wind and radar backscatter – Scatterometers – Wind speed and direction: SASS, AMI, NSCAT, SAR.

References:

1. Satellite Oceanography: I.S.Robinson, Ellis Horwood Ltd, 1985
2. Oceanographic Applications of Remote Sensing: Motoyoshi Ikeda and W.Dobson,

CRC Press, 1995
3. Methods of Satellite Oceanography: Robert H.Stewart, University of California Press, 1985
4. Satellite Microwave Remote Sensing: T.D.Allan, Ellis Horwood Ltd, 1983
5. Introduction to Satellite Oceanography: G.A.Maul, Springer, 2012
6. Climatology from Satellites: E.C.Barret, Methuen Young Books, 1974
7. Measuring the Oceans from Space: The principles and methods of satellite Oceanography: I.S.Robinson, Springer, 2004
8. The Application of Remote Sensing Technology to Marine Fisheries: An Introductory Manual – Fao Fisheries Technical Paper 295: M.J.A.Butler, M.C.Moucho, V.Baralet & C.LeBlanc, Food & Agriculture Org, 1989.

OCE E217 REGIONAL OCEANOGRAPHY (ELECTIVE) Credit : 3

Unit I

Introduction: history, major expeditions, IIOE - geographical and environmental features, uniqueness of Indian ocean- EEZ- sediment distributions – Arabian sea and Bay of Bengal system.

Unit II

Hydrography: Temperature, salinity, density and oxygen distributions, seasonal variations- General features of Red sea and Persian Gulf – Water mass – T-S diagram, T-S-V diagram- core method. Circulation: Sea level pressure distribution, wind systems and currents, monsoon current system – Somali current, Agulhas current, Leeuwin current, equatorial currents and under currents- upwelling in Arabian sea and Bay of Bengal – Indian ocean dipole mode –ITF

Unit III

Resources: Freshwater, chemicals and minerals, energy from tides, current, wave, salinity gradient energy conversion, OTEC, winds and geothermal energy.

References:

1. Glimpses of Indian ocean: S.Z. Qasim, Sangam books Ltd. 1998
2. Descriptive Physical Oceanography: George L. Pickard and William J. Emery Elsevier, 1990
3. The Encyclopedia of Oceanography Vol. I: Rhodes W. Fairbridge, Rein hold publishing corp,1966
4. Applied Oceanography: Joseph M. Bishop, John Willey and sons Inc.1984
5. Regional Oceanography- an introduction : Tomczack and J.S.Godfrey Pergmon, 1994
6. Ocean Wave Energy Conversion: M.E. McCormick, John Willey and sons Inc. 1981

OCE E218 OCEAN ENGINEERING (ELECTIVE) Credit : 4

Unit I

Engineering aspects in oceanography, Coastal protection structures- Sea walls – Groins- Break waters- Composite breakwaters utilizing geo-textile systems-Artificial reefs-Beach fill stabilization-Shore response to coastal structures-Artificial nourishment –Sediment bypassing–Type and factors determining selection of break waters- Ecological implications of

developing coastal structures- Numerical models of shoreline changes.

Unit II
Marine structures and their functions, Environmental loading-Self loading-fixed and floating structures, offshore platforms, underwater pipelines and cables, physical oceanographic parameters influencing design and construction of marine structures, hydro-dynamic forces in unsteady flow- interaction of waves on structures, sea floor soil mechanics and related engineering operations-Selection of design waves..

Unit III
Natural and artificial harbors, Siltation and control, coastal inlets and stability-Dredging, different types of dredgers- spoil ground location criteria, environmental effects of dredging-DIA,

Unit IV
Non-living ocean resources and exploitation, oceanographic factors involved in resource conservation and utilization, energy from the sea – tidal , wave and thermal energy, basic principles of desalination.

References:

1. Basic Coastal Engineering: Robert M. Sorensen, Springer; 3rd Edn, 2005
2. Physical Modeling in Coastal Engineering: R A Dalrymple, Taylor & Francis, 1985
3. Modeling Marine Systems: A M Davies, CRC Press, 1989
4. Wave Energy – A Design Challenge: R Shaw, Ellis Horwood Ltd ,1982
5. Ocean Wave Energy Conversion: M E McCormick, Dover Publications, 2007
6. Coastal Engineering :R Silvester, Elsevier Scientific Pub. Co., 1974
7. Oceanographic Engineering: R L Weigel, Dover Publications, 2005
8. Ocean Engineering – Goals, Environment, Technology: J F Brahtz, John Wiley and Sons, 1968
9. Coastlines, Structures and Breakwaters: NWH Allsop, Thomas Telford Ltd, 1998

OCE E219 OCEANS AND CLIMATE CHANGE (ELECTIVE) Credit : 4

Unit I
The basic concept – Indicators of climate change – short and long term observations – Results of scientific investigations – Study on parameters related to climate change.

Unit II
Signals from study of Temperature, weather conditions and precipitation features, sea level changes, coastal zone vulnerability, land use patterns and forests cover, Sequestering and acidification.

Unit III
The Carbon cycle - role of carbon-di-oxide content and related gases, responses from ecological systems – Impacts - Human interventions - ongoing projects in climate change studies – Robust findings and key uncertainties.

Unit IV
The ocean energy conveyor belt – influence on circulation patterns – Robust findings and key uncertainties.

References:

1. Climate Change 1992: Report – IPCC, J T Houghton, C A, Callander & S K Varney, IPCC, 1992
2. Climate Change 2001: Synthesis Report, IPCC, 2002
3. Climate Process and Change: E Bryant, Cambridge University Press, 1997
4. Global Environmental Change–Past, Present and Future: K K Jurekian, Prentice Hall, 1 Edn, 1996
5. Global Warming – The Complete Briefing: J Houghton, Cambridge University Press, 4 Edn, 2009
6. Assessing the impact of Climate Change on Natural Resource System: K D Frederick & N J Rosenberg, Springer, 1994
7. Climate Change and Climate Modeling: J D Neelin, Cambridge University Press, 2011
8. Introduction to Modern Climate Change: Andrew Dessler, Cambridge University Press, 2011
9. Hydroclimatology Perspectives and Applications: Marlyn L Shelton, Cambridge University Press; 1 Edn, 2009
10. Environmental Protection, Law and Policy: Jane Holder,Cambridge University Press 2 Edn, 2007
11. The Global Climate System: Patterns, Processes and Teleconnections: Howard A. B, John E.O, Cambridge University Press, 2006