M.Sc. Oceanography

Scheme & Syllabus applicable for CAT 2008 Admission

List of core papers

Semester – I

Course Code	Paper	Credit
OCE2101	Introductory Physical Oceanography	4
OCE2102	Geophysical Fluid Dynamics	3
OCE2103	Ocean Instrumentation	3
OCE2104	Ocean Observation (Practical)	1
OCE2105	Oceanographic Computations (Practical)	1

Semester – II

Course Code	Paper	Credit
OCE2201	Ocean Dynamics	4
OCE2202	Ocean-Atmosphere Interaction	4
OCE2203	Coastal and Estuarine Oceanography	3
OCE2204	Dynamical Computations –I (Practical)	2
OCE2205	Coastal Oceanography (Practical)	2

Semester – III

Course Code	*Paper*	*Credit*
OCE2301	Ocean Remote Sensing	3
OCE2302	Ocean Modeling	4
OCE2303	Waves and Tides	3
OCE2304	Computer Applications in Oceanography (Practical)	2

Semester – IV *

Course Code	*Paper*	*Credit*
OCE2401	Project Dissertation**	16

List of Electives

Code	Course title	Credits	Faculty	Pre-requisites
OCE E01	General Oceanography	2	CL/GUEST	GS
OCE E02	Marine Hazards	2	ANB	GS
OCE E03	Marine Pollution	2	ANB	GS
OCE E04	Ocean Optics	2	CL/GUEST	2101
OCE E05	Marine Acoustics	4	CL/GUEST	2101
OCE E06	Coastal Zone Management – I	2	ANB	GS
OCE E07	Coastal Zone Management - II	2	ANB	GS
OCE E08	Beach Dynamics	2	RS	2101
OCE E09	GIS in Oceanography	2	ANB	GS
OCE E10	Computer programming in Oceanography (Practical)	2	PKS	GS
OCE E11	Numerical Methods (Practical)	2	PKS	E10
OCE E12	Computer Programming in C (Practical)	2	PKS	GS
OCE E13	Ocean Engineering	4	RS	2101, 2203
OCE E14	Climate Change	2	ANB	GS
OCE E15	Estuarine Sediment Dynamics	2	CL/GUEST	2203
OCE E16	Ocean Circulation	2	PKS	2201
OCE E17	Remote Sensing Application (Practical)	2	CL/GUEST	2301
OCE E18	Dynamical Computations – II (Practical)	2	CL/GUEST	2204
OCE E 19	Marine Remote Sensing Applications	4	CL/GUEST	GS
OCE E20	Regional oceanography	3	CL/GUEST	2101/E01

GLMP – Graduate Level Mathematics and Physics
GS – Graduate in Science
ANB - Dr. A.N.Balchand
RS - Dr. R. Sajeev
PKS - Sri. P.K.Saji

* 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 specilisation either in the department or in an industrial/ research/

academic institution outside the University. They will be sent to different outside organisations 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 for external evaluation carrying a maximum of 50 marks. Award of internal marks (Maximum 50) to a student is given based on

a.Continuous assessment by his/her guide based on his/her performance and progress during the course of dissertation work carrying a maximum of 40 marks.
b.A presentation made in the parent department on submission of the project dissertation carrying a maximum of 10 marks awarded by the department council.

I SEMESTER

OCE 2101 INTRODUCTORY PHYSICAL OCEANOGRAPHY

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

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.

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

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

Indian Ocean: Major expeditions – wind pattern – Northeast and Southwest monsoon 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

References:

1.Descriptive Physical Oceanography : Pickard and Emery
2.Descriptive Physical Oceanography : M.P.M.Reddy
3.The Oceans, their Physics, Chemistry and General Biology : H.U. Sverdrup
4.Principles of Physical Oceanography : G. Neumann & WJ Pierson, Jr.
5.Descriptive Physical Oceanography : G Dietrich
6.Introduction to Physical and Biological Oceanography : A. M. King
7.Encyclopedia of Oceanography : Fairbridge
8.Physical Oceanography Vol I & II : A Defant
9.Introduction to Physical Oceanography : W.S. Von Arx
10.Ocean Currents : G. Neumann
11.Tides, Surges and mean sea level : D. T. Pug
12. Regional Oceanography : Tomczak M. & J.S.Godfrey
13.Ocean Circulation & Climate : Eds. Gerold Siedler, John Church & John Gould

OCE 2102 GEOPHYSICAL FLUID DYNAMICS

Basic concepts: fluid continuum, fluid properties, ideal fluid, actual fluids, types of flow; statics: pressure surface and body forces on a fluid element; fundamental equation of fluid statics: application to compressible and incompressible fluids, perfect gas equation, hydrostatic equation along the vertical, application to the atmosphere - Laplace's equation.
Kinematics: Lagrangian and Eulerian methods of description of fluid flow, stream lines, streak lines and trajectories, steady and non-steady flow, decomposition of the field of motion in the vicinity of a point, translation, rotation, divergence and deformation, physical interpretation, application to plane motion, typical flow patterns, stream function, divergence and vorticity in different co-ordinate systems, material, local and convective derivatives.

Dynamics: equation of continuity and its applications, non-viscous incompressible flow, Eulerian equations of motion, inertial and rotational frames of reference, Coriolis force, irrotational flow, velocity potential, integration of the equations of motion, Bernoulli's theorem and its applications.

Circulation and vorticity, Stoke's theorem, Kelvin's theorem, Helmholtz theorem, barotropic and baroclinic fluids, absolute and relative circulation; V.Bjerknes circulation theorem and its interpretation, potential vorticity-conservation, application to fluid flow over barriers.

Viscous fluids, coefficient of viscosity, Navier-Stoke's equations of motion for a viscous Newtonian fluid; laminar flow of viscous incompressible fluids, Poiseuille flow, Couette flow, steady flow around a sphere, Stoke's formula, Reynold's number and dynamic similarity of flows, physical significance of Reynold's number, low and high Reynold's number.

References

1.Foundations of Fluid Mechanics :S.W.Yuan
2.Physical Fluid Mechanics :D.J. Tritton
3.Fluid Mechanics :W. Kaufman
4.Geophysical Fluid Dynamics :J. Pedlosky
5.An introduction to Fluid Mechanics :G.K. Batchelor
6.An introduction to Theoretical Meteorology :S.L.Hess
7.Fluid Mechanics of the Atmosphere :Robert A Brown
8.Fluid Physics for Oceanographers and Physicists. : Samual A. Elder and J. Williams

OCE 2103 OCEAN INSTRUMENTATION

Oceanographic platforms : research vessels and their facilities - aircrafts and satellites – mooring - research towers – submersibles – drifting platforms – drifting buoys, FLIP - principles of navigation – classical and modern navigational methods – hyperbolic navigation – GPS & DGPS - Projections

Sampling requirements – sampling duration, interval and accuracy - measurement of ocean depth - Echo sounder – measurement of light - Secchi disc - transparency gauge - water sampling devices – NRWB – modifications - horizontal water sampler - Rossette water sampler - special water sampling devices.

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

Measurement of currents: Eulerian current measurements – Direct reading and Recording Current Meters - Acoustic Current Meters – Electromagnetic Current Meters - S4 Current meter - Lagrangian current measurement using drifters – ARGO floats and oceanographic gliders - profiling of currents using ADCP

Measurement of waves: surface buoys-subsurface gauges-pressure gauges-resistant gauges.

Measurement of Sea level: Tide gauge – Satellite altimetry – Inverted Echo Sounder – measurement of wind and precipitation

References

1.Instruction manual for Oceanic Observations H.O. Pub. 607 : U S Naval Oceanographic Office,
2.Marine Sciences Instrumentation : Vol.1 and Vol.2
3.Principles of Physical Oceanography :W J Pierson and G Neumann
4.Introduction to Physical Oceanography : W S von Arx
5.Oceans : Sverdrup
6.A Pictorial History of Oceanography Submersibles : J B Sweeny
7.Oceanography from Space : J F R Grower
8.Data analysis methods in Physical Oceanography : William J. E and Richard E. Thomson

OCE 2104 OCEAN OBSERVATION (Practical)

Use and operation of instruments on board (GPS, Echo Sounder, NRWB, Thermistors, Salinometer, Current meters, Lux Meter, Turbidity meter)- Familiarization of hydrographic tools - Collection of environmental data – collection of water samples using oceanographic samplers

OCE 2105 OCEANOGRAPHIC COMPUTATIONS (Practical)

Preparation of ocean parameter distribution maps, vertical sections, horizontal sections – T-S diagrams – estimation of acceleration potential – preparation of isentropic charts – interpretation of charts and sections.

II SEMESTER

OCE 2201 OCEAN DYNAMICS

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.

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

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.

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 Sverdrup
2.Physical Oceanography Vol.1 : A Defant
3.Principles of Physical Oceanography : W J Pierson and G Neumann
4.Dynamical Oceanography : J Proudman
5.Introductory Dynamic Oceanography : S Pond & G L Pickard
6.General Oceanography : G Dietrich
7.The Sea, Vol. 1 : M N Hill
8.Introduction to Physical Oceanography : W S von Arx
9.The Dynamic Method in Oceanography : Fomin
10.Oceanography for Meteorologists : H U Sverdrup
11.Ocean Currents : G Neumann
12.Introduction to Geophysical Fluid Dynamics : Cushiman Rosetin
13.Dynamics of Atmosphere and Oceans : M. N. Hill

OCE 2202 OCEAN - ATMOSPHERE INTERACTION

Introduction: fluxes of momentum, heat and water vapour – kinematic fluxes – stress – friction velocity – Turbulence: generation and maintenance – characteristics – statistical measures of turbulence – energy cascade hypothesis – Kolmogorov's local similarity theory – Taylor's hypothesis – turbulence closure – K theory – vertical structure of wind using K theory – Prandtl's mixing length concept

Theory of air-sea interaction: Scales effects of air-sea interaction - Atmospheric boundary layer - constant-flux layer – atmospheric stability – turbulent transport of fluxes - Similarity theory – flux-profile relationships – roughness length – Charnock's law - Monin-Obukhov Surface layer similarity theory for stratified atmosphere - Richardson number – effect of stability on wind profile – bulk formulation of surface fluxes – aerodynamic variables - historical drag expressions – pathways of momentum transfer – Air-sea interactions in coastal zone- Sea spray.

Measurement of Fluxes: eddy correlation method – flow distortion errors - gradient and profile methods - bulk aerodynamic method – measurement of surface aerodynamic variables – inertial dissipation technique - satellite remote sensing of air sea interaction

Large scale interactions: radiation – short wave and longwave radiation – radiation balance – turbulent heat fluxes – sensible and latent heat fluxes – heat budget – climatology of energy exchange and global heat and water budgets – annual cycle of air-sea fluxes - heat transport by ocean and atmosphere – long-term variations – El Nino

References

1.The Sea (Vol 1) , (ed) :M. H. Hill
2.Atmosphere-Ocean interaction : Kraus E.B.
3.Introduction to Boundary Layer Meteorology : Stull R. B
4.Introduction to Micrometeorology : S. Pal Arya
5.Air-Sea exchange: Physics, Chemistry and Dynamics : G. L. Geernaert
6.Small scale processes in Geophysical fluid flows : L. H. Kantha and C. A. Clayson
7.Wind stress over the ocean : Ian S. F Jones and Y. Toba
8.Ocean-Atmosphere interactions : Y. Toba

OCE 2203 COASTAL AND ESTUARINE OCEANOGRAPHY

Sea Coasts and shorelines, shoreline features, beaches, coastal processes, factors influencing coastal processes, River-estuary-near shore systems, sea level variations and the coast.

Coastal zone management, environmental characteristics and conditions, Leopold matrix, oceanographic aspects in coastal zone protection, impact assessment for

coastal environment, coastal zone of India, mud banks, EEZ and is importance, law of the sea.

Wave transformation in shallow waters, effect of bottom friction, phenomena of wave reflection, refraction and diffraction, breakers, littoral currents. Wave action on sediments, movement of beach material, beach stability.

General characteristics of estuaries, classification and nomenclature, stratification, estuarine circulation and mixing, tidal prism, entrainment, sedimentation in estuaries, flocculation and turbidity maxima.

References

1.Estuary and Coastline Hydrodynamics :A T Ippen
2.Estuaries: A Physical Introduction :K R Dyer
3.Estuaries :G H Lauff
4.Beaches and Coasts :C A M King
5.Waves and Coast :R E Meyer
6.The Coast Line :R S K Barnes
7.Stability of Coastal Inlets :P Brunn and Gerritsen
8.Shelf Sediment Transport Processes and Pattern :D J P Swift
9.Oceanographical Engineering :R L Wiegel
10.Coastal Zone Management :J R P Brathz

OCE 2204 DYNAMICAL COMPUTATIONS –I (Practical)

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)

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.

III SEMESTER

OCE 2301 OCEAN REMOTE SENSING

Introduction to Remote Sensing - Basic concepts – principles of areal photography - electromagnetic radiation – solar and terrestrial radiation - atmospheric effects – absorption, transmission and scattering – spectral response of earth's surface features – atmospheric windows – concept of signature

Remote sensing platforms – satellite orbits - near polar, geostationary and sun-synchronous satellites – swath – spatial, temporal, spectral and radiometric resolution – LANDSAT, SPOT, IRS, INSAT, SEASAT, ERS, JERS, MOS, RADARSAT - sensors – active and passive sensors – sensor calibration - visible, thermal and

microwave sensors and their applications in oceanography – data transmission, reception, processing and dissemination – sea-truth data validation

Visible remote sensing: theory of ocean colour remote sensing - optical properties of pure water, natural waters and atmosphere – optical pathways in the atmosphere – reflection and refraction at the surface – scattering and absorption of light underwater – reflection from sea bed – colour of the sea : phytoplankton, yellow substance, suspended particulate matter – case 1 and case 2 waters – estimating water parameters – satellite sensors for ocean colour - CZCS, SeaWiFS, OCTS, MOS, MODIS, OCM, LISS I & II – calibration and validation of ocean colour – applications

Infrared Remote Sensing: thermal emission – atmospheric absorption – IR sensors – SST retrieval – atmospheric correction – effect of cloud – thermal skin layer – skin and bulk SST - effect of surface films – Infrared radiometers – AVHRR, ATSR, OCTS, MODIS, AATSR, TM - global SST data: NASA pathfinder, ASST – calibration and validation of SST – applications

Mocrowave Remote Sensing: theory of microwave radiometry – microwave emission of sea surface – atmospheric effects – retrieval of salinity and wind vector – passive microwave radiometers: SMMR, SSM/I, TRMM/TMI and AMSR – active microwave radiometers: mocrowave interaction with the sea surface – low, intermediate and high incidence angles – wind and radar backscatter – scatterometers: SASS, AMI, NSCAT, SeaWinds – SAR: principles - SAR imaging of wind speed and direction, ocean waves, internal waves, shallow bathemetry – Altemetry: principles – atmospheric correction – sea surface height anomaly – ERS, T/P, Jason-1 – observing planetary waves and eddy energy

References

1.Satellite Oceanography : I.S. Robinson, Ellis Horwood
2.Oceanographic Applications of Remote Sensing : Motoyoshi Ikeda and W.Dobson
3.Methods of Satellite Oceanography : Robert H.Stewart.
4.Satellite Microwave Remote Sensing : T.D. Allan
5.Introduction to Satellite Oceanography : G.A. Maul
6.Climatology from Satellites : E.C. Barret
7.Measuring the Oceans from space: *The principles and methods of satellite Oceanography* : I. S. Robinson, 2004

OCE 2302 OCEAN MODELING

Introduction, type, advantage and limitations of models – modelling issues - development of models-governing equations and approximations-physical and numerical modeling

Finite difference methods – computation errors - Implicit and explicit finite difference

schemes - boundary conditions - stability criteria- computational instability - finite element methods

General approach to numerical modeling of ocean circulation-Physical processes involved in modeling of upper ocean – Concepts of 1,2,3, and 4 D modeling-Geostrophic adjustment – barotropic and baroclinic instabilities – spin up - Quasi geostrophic models - O'Brien's 2 D Models – Cox's model of Indian Ocean - POM and MOM models.

Tide and Storm surge modeling – Climate system – components and processes - Ocean atmosphere coupled models - Ocean General Circulation Models – hydrographic data inputs - new data produced by models - Model validation - Data assimilation – verification of models - nowcast and forecast – forecasting ENSO

References

1.Introductory Dynamical Oceanography : Stephen Pond & George L.Picard

2.Dynamics & Modelling of Ocean waves : Komen et.al.

3.Introduction to the modeling of Marine eco-systems: W.Fennel & T.Newmann

4.Numerical modeling of Ocean dynamics : Z Kowalik & T.S.Murthy

5.Numerical Modelling of Oceans and Oceanic Processe : Lakshmi H.Kantha & Carol Anne Claysor

6.Mathematical modeling and estuarine Physics : J Sundermann & K P Holz

7.Modeling and prediction of the upper layer of the ocean : E B Kraus

8.Oceanic circulation models combining data and dynamics : D L T Anderson & Willebrand

9.Ocean circulation physics : M E Stern

10.Numerical modeling of marine Hydrodynamics – Application to dynamic physical processes : H G Ramming & Z Kowalik

11.Offshore and coastal modeling : P P G Dyke, A O Moscardini and E H Robson

12.Physical Modeling in coastal engineering : R A Dalrymple

13.Modeling Marine systems : A M Davies

14.Computer modeling in Atmospheric and Oceanic Sciences : Peter Muller and Hans Von Storch

OCE 2303 WAVES AND TIDES

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.

Finite amplitude waves: Girstner'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.

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 : B.Kinsman
2.Physical Oceanography . Vol.II : A.Defan.t
3.Introductory Dynamical Oceanography : S.Pond and G.L.Pickard
4.Waves : Coulson
5.Estuary and Coastline Hydrodynamics : A.T.Ippen
6.Principles of Physical Oceanography : W.J.Pierson and G.Neumann.
7.The Oceans : H.U.Sverdrup et al.
8.Oceanographical Engineering : R.L.Weigel
9.Dynamical Oceanography : J.Proudman
10.Adminarility Manual of Tides : A.T.Doodson and H.D.Warbin
11.The Tides : H.Darwin
12.Hydrodynamics : H.Lamb
13.Observing and Forecasting Ocean Waves : W.J.Pierson
14.Wave Spectra and Statistics : G.Neumann and James

OCE 2304 COMPUTER APPLICATIONS IN OCEANOGRAPHY (PRACTICAL)

Graphical presentation and interpretation: Vertical profiles of temperature, Salinity, Density – Horizontal and vertical structure – time series – histogram – scatter diagram

Computation of density, sigma-t, specific volume anomaly, sound velocity etc. and their vertical structure in the ocean.

Computation of ocean surface current from drifting buoys – spectral analysis –

harmonic analysis – Ocean mixed layer
Large scale processes: Climatology of temperature, salinity, wind, and heat flux. Seasonal variability of sensible and latent heat fluxes – heat balance – Observation of Kelvin and Rossby waves from sea surface height anomaly – Observation El Nino from SST.

IV SEMESTER

OCE 2401 PROEJCT DISSERTATION

ELECTIVES

OCE E 01 GENERAL OCEANOGRAPHY

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

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.

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 : Pickard and Emery
2.Descriptive Physical Oceanography : M.P.M.Reddy
3.The Oceans, their Physics, Chemistry and General Biology : H.U. Sverdrup
4. Principles of Physical Oceanography : G. Neumann & WJ Pierson, Jr.
5.Descriptive Physical Oceanography : G Dietrich

OCE E02 MARINE HAZARDS

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

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

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
2.Ocean Environmental Management :E.G.Frankel
3.Encyclopedia of Disaster Management :P.C.Sinha
4.Environmental Hazards-Assessing Risk and Reducing Disasters :K. Smith
5.Global Environmental Change: Past, present and future :T. L. Viarl

OCE E03 MARINE POLLUTION

Pollution of the oceans - kinds of pollution, Marine pollutants and their sources. Types of pollutants – physical, chemical, biological, thermal, radioactive and non-point. Effects of pollution.

Oceanographic factors involved in dispersing pollutants - The transport phenomenon, advective and diffusion aspects. Dispersal of pollutants in estuaries and near shore areas, physical oceanographic factors affecting marine pollution.

Control and abatement of marine pollution, effluent outfalls, radioactive waste disposal, containment of oil at sea, Oil slicks and their management- chemical dispersants – water quality parameters and standards – procedure and instrumentation

Monitoring strategies, Global waste management and the oceans, hazardous material transport, carrying capacity, 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, Vol. 6 :Jean Marie Massin
2.Marine Environment Pollution :Richard A Geyer
3.Water and Water Pollution :L L Ciaccio
4.Ocean Dumping and Marine Pollution :M G Gross
5.Dispersion in Estuaries and Coastal Waters :Lewis
6.Water and Water Pollution :L L Ciaccio
7.Oceanic Processes in Marine Pollution :J M Capuzzo & D R Kester
8.Ocean Dumping and Marine Pollution :M Grant Gross

OCE E04 OCEAN OPTICS

Introduction – Characterisation 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 – Rayliegh scattering Mie scattering –

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, Photosynthetically Active Radiation.

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 - Under water photography and Imaging instruments.

Reference:

1.Marine Optics : N.G.Jerlov
2.Physical Optics of Ocean waters : K.S.Shifrin
3.Colour of Inland and Coastal waters : Dimitry Pozdnyakov and Hartmut Grass1
A methodology for its
interpretation

OCE E05 MARINE ACOUSTICS

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.

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.

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.

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.

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
2. Acoustical Oceanography : Clay and Medwin
3. Underwater Observation Using Sonar : D.G.Tucker
4. Underwater Acoustics : Leon Camp
5. Applied Underwater Acoustics : D.G.Tucker and B.K.Gazey
6. Introduction to the Theory of Sound Transmission : C.B.Officer
7. Principles of Underwater Sound for Engineers : R.J.Urik
8. Ocean Acoustics : Tolstoy and Clay
9. Theory and Experiments in Underwater Sound : N.N.Rao
10. Ocean acoustic tomography : a scheme for large scale monitoring" . Munk, W. and C.Wunsch (1979). Deep Sea Res., 26A, PP. 123-161
11. The Ocean Tomography Group (1982). "A demonstration of ocean acoustic tomography". Nature, 299, PP. 121-125

OCE E06 COASTAL ZONE MANAGEMENT - I

Concepts, definition and approach – Coastal Zones of the World – Natural process – developmental activities - conservation measures - coastal resources and utilization.

Terrestrial and marine influences on coastal zone - human impacts and management approaches – different management options - - coastal hygiene - coastal pollution – monitoring - health hazards - coastal vulnerability analysis - planning and developmental approaches in CZM - sustainable development

Legal Regime - territorial sea and EEZ - law of the sea and CZM - socio-economic issues - participatory dialogues and group intervention

References

1.Coastal Zone Management : J.R.P.Bzattiz
2.Fluvial Processes and Environmental Changes : Brown
3.Perspectives on Integrated CZM : W Salomens.

4.Coastal Environment Response and Management : Chartier and Meyer.

OCE E07 COASTAL ZONE MANAGEMENT - 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

Coastal land - sea uses - landscaping and traditional practices – Indian coastal policy – CRZ – strategic planning.

Natural coastal hazards – classification - climate and impacts – role of human activities - disaster mitigation

References

1.Advances in Coastal and ocean engineering : Philip L.F
2.Statistical Data Analysis for ocean and
3.Atmospheric services : H.J.Thiebaux
4.Perspectives on Integrated coastal zone Management : W Saloman
5.Coastal erosion, Response and management: C.H.Roger
6.Subtle Zones in coastal Zone Management : R.Sudarshana
7.Environmental Assessment-IEA guidelines- : A practical guide to EIA : E.A.Paul
8.CZM handbook : R.J.Clark.

OCE E08 BEACH DYNAMICS

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.

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
2.The Coastline : R S K Barnes
3.Waves on beaches : R E Mayer

4.Coasts – An Introduction to Coastal Geomorphology : C F Bird
5.Coastal Sedimentary Environments : R A Davies
6.Coastal Environments : R W L Carter

OCE E09 GIS IN OCEANOGRAPHY

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

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
2.Coastal and Marine Geo Information Systems : D R Green & S D King
3.Geographic Information Systems in Oceanography and Fisheries : V D Valavanis
4.Wetland and Environmental Application of GIS : JGLyon & J MaCarthy
5.An Introduction to GIS : I Heywood, S Cornelius & S Carver
6.GIS & Science :P.A.Longley,MF Goodchild, D J Maguire & D W Rhind
7.GIS – An Introduction : T Bernhardsen
8.GIS – Basic : S Wire
9.Integration of GIS and RS : J L Star, J E Estes and K C, McGwire
10.GIS & Multi criteria Decision Making :J Malczewski
11.Spatial Models and GIS New Potential and New Modes (GIS DATA 7) :I Masser, F Salge, A S Fotheringham & M Wegner,
12.Innovations in GIS 5 :S Carver

OCE E10 COMPUTER PROGRAMMING IN OCEANOGRAPHY (Practical)

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 E11 NUMERICAL METHODS (Practical)

Numerical computing – evolution – computer organisation – programming languages – problem solving and algorithms – flow charting - decimal, binary, hexadecimal and octal systems – integer and floating-point representation – errors in arithmetic -

Roots of nonlinear equations – evaluation of polynomials – bisection , false position, Newton-Raphson, and Secant methods
Curve fitting: lagrange interpolation method – spline interpolation – fitting linear equations -

Numerical differentiation: forward difference and central difference scheme – Numerical integration: Newton-Cotes method – Trapezoidal rule – Simpson's rule – Gaussian Integration
Numerical solution of partial differential equations – elliptic, parobolic and hyperbolic equations

OCE E12 COMPUTER PROGRAMMING IN C (Practical)

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 E13 OCEAN ENGINEERING

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.
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..

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,

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
2.Physical Modeling in Coastal Engineering	:	R A Dalrymple
3.Modeling Marine Systems	:	A M Davies
4.Wave Energy – a Design Challenge	:	R Shaw
5.Tidal Power	:	Institution of Civil Engineers, U K
6.Ocean Wave Energy Conversion	:	M E McCormick
7.Tidal Power	:	G Gashus
8.Coastal Engineering	:	R Silvester
9.Oceanographic Engineering	:	R L Weigel
10.Ocean Engineering – goals, environment, technology	:	J F Brahtz
11.Ocean Engineering	:	ASCE
12.Coastlines, structures and breakwaters	:	NWH Allsop

OCE E14 CLIMATE CHANGE

The concept – An integrated framework – Indicators of climate change – short and long term observations – Results of scientific investigation – Predictions – Study on parameters related to climate change.

Signals from study of Temperature, global warming, role of carbon-di-oxide content and related gases, sea level changes, coastal zone vulnerability, land use patterns and forests cover, precipitation features, weather conditions and agricultural practices – ongoing projects in climate change studies.

The ocean energy conveyor belt – influence on circulation patterns – The Carbon cycle – responses from ecological systems – Impacts - Human interventions – Robust findings and key uncertainties.

References:

1.Climate Change 1992	: Report – IPCC, J T Houghton, C A, Callander & S K Varney
2.Climate Change 2001	: Synthesis Report – IPCC, 2002
3.Climate Process and Change	:E Bryant
4.Global Environmental Change – Past, Present and future	: K K Jurekian
5.Global Warming – The Complete Briefing	:J Houghton
6.Assessing the impact of Climate Change on Natural Resource System	:K D Frederick & N J Rosenberg

OCE E15 ESTUARINE SEDIMENT DYNAMICS

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.

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.

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
2.Sedimentation and Deposition :Rhodes and Moslow
3.Dynamics of Marine Sands :Soulsby
4.Mechanics of Coastal sediment transport :Fredsee and Deigaard
5.Physics of Estuaries and Coastal Seas :Dronkers and Scheffers
6.Estuaries a Physical Introduction :Dyer, K. R
7.Estuarine Hydrography and Sedimentation :Dyer, K. R.

OCE E16 OCEAN CIRCULATION

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;

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

The Oceans	:	H U Sverdrup
Physical Oceanography Vol.1	:	A Defant
Principles of Physical Oceanography	:	W J Pierson and G Neumann
Dynamical Oceanography	:	J Proudman
Introductory Dynamic Oceanography	:	S Pond & G L Pickard
General Oceanography	:	G Dietrich
The Sea, Vol. 1	:	M N Hill
Introduction to Physical Oceanography	:	W S von Arx
The Dynamic Method in	:	Fomin

OCE E17 REMOTE SENSING APPLICATIONS (Practical)

Digital Image processing, data products generation, image classification, vector overlays, multispectral classification, Introduction to Hyperspectral analysis, Basic hyperspectral analysis, Hyperspectral signatures and spectral resolution, supervised and unsupervised classification, Image georeferencing and registration, Orthorectification of images , Image mosaicking, Image data fusion,

Data analysis - Near shore marine hyperspectral analysis, Introduction to Digital Elevation Models and its analysis, Basic SAR processing and analysis, Introduction to HDF(Hierarchical Data Format) and its processing, Satellite data processing techniques using SeaDAS, BEAM and ENVI and ERDAS-IMAGINE Software.

OCE E18 DYNAMICAL COMPUTATIONS – II (Practical)

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

OCE E19 MARINE REMOTE SENSING APPLICATIONS

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.

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.

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

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
2. Oceanographic Applications of Remote Sensing: Motoyoshi Ikeda and W.Dobson
3. Methods of Satellite Oceanography : Robert H.Stewart
4. Satellite Microwave Remote Sensing : T.D.Allan
5. Introduction to satellite Oceanography : G.A.Maul
6. Climatology from Satellites : E.C.Barret
7. Measuring the Oceans from space:
   The principles and methods of satellite Oceanography: I.S.Robinson, 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

OCE E20 - REGIONAL OCEANOGRAPHY

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

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

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 (1998), Sangam books Ltd.

2. Descriptive physical oceanography: George L. Pickard and William J.Emery (1990). Elsevier.
3. The Encyclopedia of oceanography Vol. I : Rhodes W. Fairbridge (1966). Rein hold publishing corp.
4. Applied oceanography : Joseph M. Bishop (1984). John Willey and sons Inc.
5. Regional oceanography- an introduction : Tomczack and J.S.Godfrey (1994), Pergmon
6. Ocean wave energy conversion: M.E. McCormick (1981). John Willey and sons Inc.