

M. Phil MARINE CHEMISTRY – COURSE STRUCTURE

| I SEMESTER | | | | | | |
|-----------------------------|------------------------|--|----------------|-----------------------------|---------------------------------|--------------|
| Course Code. | Core / Elective | Subject | Credits | Continues Evaluation | End Semester Examination | Total |
| COD4101 | Core | Introduction to Marine Chemistry | 5 | 60 | 40 | 100 |
| COD4102 | Core | Research Methodology and Quantitative Techniques | 5 | 60 | 40 | 100 |
| COD4103 | Core | Literature Review and Seminar | 3 | 100 | - | 100 |
| COD4104 | Elective (Any one) | Marine Pollution | 5 | 60 | 40 | 100 |
| COD4105 | | Marine Natural Products | | | | |
| COD4106 | | Marine Chemical Resources | | | | |
| COD4107 | | Advanced Instrumentation | | | | |
| COD4108 | | Remote Sensing and GIS | | | | |
| Total for I semester | | | 18 | 280 | 120 | 400 |

| II SEMESTER | | | | | | |
|-----------------------------|------|----------------------------------|-----------|------------|------------|------------|
| COD4201 | Core | Project Evaluation and viva voce | 18 | 100 | 300* | 400 |
| Total for the Course | | | 36 | 380 | 420 | 800 |

* Out of the 300 marks, 200 shall be for the evaluation of the dissertation and 100 shall be for the viva voce examination. Both these evaluations shall be done by the internal and the external examiners.

SYLLABUS

COD4101 - INTRODUCTION TO MARINE CHEMISTRY

Marine environment : General introduction. Dimensions of ocean, physical properties of seawater, distributions of salinity, temperature and density. General circulation, important currents of the world ocean.

The ocean floor, general topography of the ocean floor, continental shelves, slopes, submarine canyons, submarine ridges and trenches.

Sea as a biological environment – plankton, nekton, benthos – marine ecosystems, marine food web, trophic structure - primary and secondary production and factors influencing them.

Ocean as a chemical system : origin of seawater, structure of water, ion-water interactions, the polarized water molecule, colligative properties of seawater, comparison of river and sea water, hydrological cycle and budget. History of oceanography and important oceanographic expeditions.

Classification of elements based on their distribution - major and minor constituents - behavior of elements - chemical exchanges across interfaces and residence times in seawater.

Dissolved gases and trace elements : solubility in sea water, carbon dioxide-carbonate system, alkalinity and control of pH, global carbon cycle. biological pump and controls on atmospheric composition - emission of green house gases.

Abiotic and biotic controls of trace elements in the ocean;; biogeochemical processes in aerobic and anaerobic environments; Primary, cosmogenic and artificial nuclides, Applications of radioisotopes in oceanography.

Micro-nutrients and organic compounds : Nitrogen, phosphorus and silicon, their cycles, distribution profiles and their effect on phytoplankton growth, water column-denitrification – source, nature and fate of organic compounds in the sea.

References

1. Marine Biology – an ecological approach (fifth edition), J.W. Nybakken. Addison Wesley Longman Inc. . 2001.
2. An Introduction to World Oceans (sixth edition), A.C. Duxbury, A.B. Duxbury, K.A. Sverdrup. Mc Graw Hill Publishers. 2000.
3. Descriptive physical oceanography (6th edition), L.D. Talley, G.L.Picard and W.J. Emery and J.H. Swift. Elsevier. 2011.
4. Fundamentals of Ecology, Eugene P Odum. Nataraj Publishers. 1996.
5. Textbook of Marine Ecology, Nair, N.B. and Thampy, D.M. Macmillan Company of India (Wasani). 1989.
6. Oceanography (second edition), T.Garrison. Wadsworth Publishing Company. 1995.
7. Chemical Oceanography, 3rd Edition, Millero, Frank J. CRC Press 2006 or 2nd Edition, CRC Press, 1996.
8. Invitation to Oceanography (fourth edition), Pinet, Paul R., Jones and Bartlett Publishers, Sudbury , Massachusetts. 2003
9. Introduction to Marine Chemistry, J.P.Riley and R.Chester. Academic Press 1971.

10. The Open University Seawater : its Composition, Properties and Behaviour (II edn.) Oceanography Series, Pergamon 1995.
11. Marine Ecology, O. Kinne. Vol.I Pt.3, Vol.III Pt.3 (1976), Wiley Inter-science. 1972.
12. Chemical Oceanography, J.P.Riley and G.Skirrow. Vols. I to III, Academic Press 1975.
13. The Open University Ocean Chemistry and Deep-Sea Sediments Oceanography Series Pergamon. 1989.
14. Methods of Seawater Analysis, 3rd completely revised and extended edition, K.Grasshoff, K.Kremling and M. Ehrhardt (Eds), Wiley, VCH, 1999.

COD4102 - RESEARCH METHODOLOGY & QUANTITATIVE TECHNIQUES

Science Writing

Introduction - science writing – goals, key elements – critical aspects – precision, clarity, objectivity. Genre in science writing -- peer-reviewed journal articles, grant proposals, literature review articles. Writing a scientific manuscript - foundations of a good scientific paper. Science journalism – science communication and science popularization

IPR and Patents – TRIPS – Paris Convention – Industrial property, copyright, patents, trademarks, industrial designs, geographical indicators. Patents –legislations covering IPR and Patents in India, term of patent in Indian system, International / global patent.

e-publishing – overview –contrast with traditional – role of technology – creativity and designing, tools and techniques, advantages and disadvantages.

Sampling and Storage

Protocols and techniques for sampling water and sediment, water samplers, sediment samplers. Sample pre-treatment, separation and storage for major and minor ions, nutrients, trace metals, organic compounds.

Hydrographic parameters

Analytical techniques for dissolved oxygen, salinity, nutrients. Pigments and productivity – estimation of chlorophyll a, b, c, phaeopigments, productivity, BOD, COD.

Quantitative analyses

Estimation of major ions, hardness, Calcium, Magnesium, alkalinity, Na, K, SO₄. Electro-analytical techniques – ion selective electrodes. Data analysis – types and propagation of errors, accuracy, precision, least square analysis, standard deviation, statistical packages.

References

1. The Craft of Scientific Writing, Michael Alley, 3rd ed., Springer, 1996
2. Intellectual Property Rights In India : General Issues And Implications, Prankrishna Pal, Deep & Deep Publications Pvt. Ltd, 2008
3. Methods of Seawater Analysis Third completely revised and extended edition, K.Grasshoff, K. Kremling and M. Ehrhardt (Eds), Wiley-VCH, 1999
4. Extraction methods for environmental analysis, John R. Dean, Wiley, 1998
5. D.T.E. Hunt and A.L.Wilson, The Chemical Analysis of Water (II edn.), Royal Society of Chemistry, 1990
6. APHA Standard Methods for the Examination of Water and Wastewater, 1985

7. A Manual of Seawater Analysis, J.D.H. Strickland and T.R. Parsons, Ottawa, Fisheries Research Board of Canada, Revised Second Edition, 1965
8. A Manual of Chemical and Biological Methods for Seawater Analysis, Timothy Richard Parsons, Yoshiaki Maita and Carol M. Lalli, Paperback, Pergamon Press, 1984
9. IOC/EPA/UNESCO Manuals and Guides
10. Vogel's Text Book of Quantitative Inorganic Analysis (IV edn.), J.Bassett, R.C.Denney, G.H.Jeffery & J.Mendham, ELBS, 1986

COD 4104 - MARINE POLLUTION

Marine Pollution: Definition and Historical background. Major Pollutants. Organic wastes Consequences of organic discharges to estuaries. Sewage treatment: Primary, secondary and tertiary treatment and disposal of sewage sludge.

Oil Pollution, Fate of spilled oil, Treatment of Oil at Sea, Toxicity of Petroleum, Consequence of oil pollution on coastal environment. Control of oil pollution in seawater. Pesticide Pollution: inputs, fate in the sea, biological effects of pesticides and their preventive methods.

Conservative pollutants. Measures of contamination, toxicity, measurement of toxicity, acute and chronic exposure. Detoxification. Heavy metal pollution in coastal waters (Hg, Pb, Cd, As, Cu, Zn and Fe). Speciation of pollutants in sediments and biological systems.

Radioactive pollution sources, nature and ecological impact of radioactivity.

Thermal pollution: Sources, nature and ecological impacts. Assessing Pollution Damage.

Micro and macro fouling on marine structures. Protection methods against corrosion and fouling. Deterioration of wood in the sea. Present status of coastal pollution in India and Future strategies. The state of some seas in the world.

Monitoring Strategies : Evaluation – Interaction with biological systems – Sentinel organism concept, bioavailability, bioconcentration, biomagnification. Microbial indicators – problems and potentials.

References

1. Marine Pollution, third edition, R.B. Clark, Clarendon Press-Oxford. 1995.
2. Introduction to Marine Pollution Control, Williams. J, Wiley, Interscience Publications. 1987.
3. Chemical Speciation in the Environment. Ure, A.M. & Davidson C.M. Chapman and Hall Pub. 1995.
4. Thermal and Radioactive pollution, Sharma B.K & Kaur, H. 1994.
5. Quantitative Aquatic Biological Indicators, Phillips J.D. H. Applied Science Publishers. 1980.
6. Marine Bio-deterioration: An interdisciplinary study, Costlow J.D. and Tipper, R.C. Naval Institute Press. 1988.
7. Marine and Offshore Corrosion, Chandler K.A. Butterworth pub. 1985.
8. Marine Pollution, P.C. Sinha. Anmol pub. 1998.

9. Marine Pollution New Research. Tobias N. Hofer. Nova Science Pub. 2008.
10. Environmental Hazards: Marine Pollution, Martha Gorman, ABC-CLIO; Later Printing edition, 1993.
11. Environment, Effluent, Emission Standards and Guidelines, Kerala State Pollution Control Board, Thiruvananthapuram, 1997.

COD 4105 - MARINE NATURAL PRODUCTS.

Marine natural products, valuable chemicals, bioactive compounds from micro-algae
 Macroalgal polysaccharides:- Properties , applications and manufacture of agar, agarose and carrageenan. Alginate- general uses and applications of alginate microcapsules for transplantation of cells (like Islets of Langerhans) Eicosanoids and related compounds from Marine Algae. Biological uses of Omega-3 polyunsaturated fatty acids and production of DHA and EPA from microalgae

Marine pharmacology- Bioactive natural products (anti-bacterial, anti-fungal, anti-viral, anti-inflammatory, anti-tumour, anti-parasitic and anthelmintic) from macroalgae, marine bacteria, dinoflagellates, coelenterates (corals), bryozoans, sponges, and tunicates

Biotechnological application of commercially important enzymes from marine microorganisms & Extremozymes from Extremophiles biomedical and bioactive compounds from marine organisms, commercial bio-products from marine organisms, Marine biotechnology for economic development and environmental problem solving, Applications of chitosan in separation and purification of metals. Molecular biology and applications of green mussel adhesive protein. Marine bio-film and bio-remediation, marine bio-sensor and transgenic marine organisms.

References

1. Marine Biotechnology Vol I. Pharmaceutical and Bioactive Natural Products Edited by D.H. Attaway and O.R. Zaborsky, Plenum Press, USA. 1993
2. Highlights of Marine Natural Products Chemistry (1972-1999). D. J. Faulkner, Natural Products Report,17: 2000.
3. Marine Pharmacology. D. J. Faulkner, Antonie van Leeuwenhoek, 77:135-145, 2000.
4. Biosynthesis of Marine Natural Products: Microorganisms and Macroalgae. B. S. Moore, Natural Products Report, 16: 653- 674, 1999.
5. Recent Advances in Marine Biotechnology. Vol 2. Fingerman, M., Nagabhushanam, R. and Thompson, M. Oxford & IBH Publishing, 1998.
6. Marine Natural Products- Diversity and Biosynthesis. Current Chemistry Vol 167: Scheuer PJ. 1993
7. Marine Natural Products Reviewing the literature. Faulkner, D.J. Natural Product Report. 12: 1995.
8. Bioactive marine natural products, D.S. Bhakuni and D.S. Rawat, Springer, 2005.
9. Encyclopedia of marine natural products. Jean Michel Kronprobst. Willey Blackwell pub. 2011.

COD4106 - MARINE CHEMICAL RESOURCES

Aquatic resources: Renewable and non-renewable resources – estimation – primary productivity – factors affecting, regional variations

Desalination: Principles and applications of desalination – distillation, solar evaporation, freezing, electrodialysis, reverse osmosis, ion-exchange and hydrate formation methods, relative advantages and limitations- scale formation and its prevention in distillation process.

Non renewable resources: Inorganic chemicals from the sea – extraction and recovery of chemicals – salt from solar evaporation, halide, magnesium, potassium, gold.

Phycochemistry: Seaweeds and its economical importance – structure, manufacture and uses of agar, alginates, carrageenan and furcellaran. Storage products: □(1,4) linked glucans - floridean starch, and other mycophycen and chlorophycen starches; □(1,3)linked glucans – laminarin, chrysolaminarin and paramylon starches.

Marine Drugs: Chemical and pharmacological aspects – carbohydrates and derivatives, aliphatic acids and derivatives, steroids and terpenoids, nitrogenous compounds; antibiotic compounds from sponges, cephalosporines and fish and shellfish toxins.

References

1. Fundamentals of Water Desalination, E.D.Howe, Marcel Dekker. 1974.
2. Saline Water Processing, H.G.Heitmann, VCH Publ. 1990
3. Minerals from Sea Salt. S.N. Leville
4. Seaweeds and their uses, V.J. Chapman and D.J. Chapman. Methuen and Co. Ltd. 1980
5. Marine Natural Product Chemistry, D.J.Faulkner and W.H.Fenical Plenum Press. 1977
6. Pharmaceuticals and the Sea, C.W. Jefford, K.L.Rinehart and L.S. Shield Technomic Publ. Co.1988
7. Chemical Oceanography, J.P. Riley and G. Skirrow Vol. IV (II edn), Academic Press. 1975.

COD 4107 - ADVANCED INSTRUMENTATION

Thermal Analysis – Differential Scanning Calorimetry, Thermogravimetry, Differential Thermal Analysis, Thermomechanical Analysis, Thermometric titrimetry and Direct Injection Enthalpometry,

X-Ray Methods – Production of X-Rays and X-Ray spectra, General Instrumentation and detectors, X-Ray absorption, Fluorescence and Diffraction Techniques, Auger Emission Spectroscopy (AES) and Electron Spectroscopy for Chemical Analysis (ESCA)

Radiometric methods – Measurement of Radioactivity, Activation Analysis and Isotope Dilution Techniques

NMR – Basic Principles and Instrumentation of Continuous Wave and Pulsed Fourier Transform
NMR Spectrophotometers, Spectra and Molecular Structure

Mass Spectrometry – Basic Principles, Instrumentation – Sample flow, Ionisation methods, mass analysers, Ion collecting systems, Analysis of data, , Fourier Transform Mass Spectrometry, MS-MS, ICP-MS, SIMS, IMMA

References

1. Instrumental Methods of Analysis, (VI edn), H.H. Williard, L.L., Merit J.A.Dean and F.A.Settle, CBS Publ. and Distrib. 1986.
2. Fundamentals of Analytical Chemistry (VI edn.), D.A. Skoog and D.M. West. F.J.Holler Saunders College Publ. 1992.
3. Principles of Instrumental Analysis (IV edn.), D.A.Skoog and J.J.Leary Saunders College Publ. 1992.
4. Vogel's Text Book of Quantitative Inorganic Analysis. J.Bassett, R.C.Denney G.H.Jeffery & J. Mendham(IV edn.), ELBS. 1986.
5. Nuclear and Radiochemistry, G.Friedlander, J.W.Kennedy & J.M.Miller. John Wiley and Son 1965.
6. An Introduction to Nuclear Physics and Chemistry, B.G. Harvey, Prentice Hall. 1962

COD4108 - REMOTE SENSING AND GIS

Introduction to satellite remote sensing of the ocean; Propagation and sensing of EM waves and their interaction and scattering with the ocean's surface; Atmospheric absorption and scattering of microwave; visible and infrared radiation; Celestial mechanics for understanding orbital dynamics and geometric distortions; Brief review of electromagnetic wave theory, antenna patterns and ocean surface processes; Detailed survey of major instruments for measuring oceanographic variables from space; applications of visible, infrared, and microwave observations using objective, multi-spectral, and characteristic vector analysis; Emphasis on new methodologies, error assessments, sampling considerations and data interpretation

References

- 1.Optical Properties and Remote Sensing of Multicomponent Water Bodies, Helgi Arst, Springer and Praxis Publishing Ltd, UK, 2003.
- 2.Optical properties and remote sensing of Inland and coastal waters, Robert. P. Bukata, J. H. Jerome, K. Y. Kondratyev and D.V. Pozdnyakov, CRC Press Inc.,2000.
- 3.Remote Sensing of Ocean Colour in Coastal and Other Optically-complex Waters; IOCCG Report No. 3, Shubha Sathyendranath, (Ed)., 2000.