KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES

Panangad, Kochi- 682506, Kerala

Msc. Marine Chemistry

Syllabus

2020

Regulations, Eligibility, Scheme and Syllabus for MSc. Marine Chemistry

(Effective from 2020 Admission onwards)

All the general rules and regulations laid down by the Kerala University of Fisheries and Ocean Studies PG Curriculum shall be applicable.

ELIGIBILITY CRITERIA.

Those students who possess B.Sc. Degree in Chemistry (Any branch) are eligible for admission to this Programme.

PROGRAMME AND SCHEME OF EXAMINATIONS

1. M.Sc. Marine Chemistryprogramme shall have 4 core courses and 2 core practical courses each in first three semesters along with 1 elective course in 1st semester and 2 elective courses each in 2nd semester and 3rd semesters. Of these 4 elective courses, 2 will be offered by the department and 2 open electives shall be opted by the students. During the course, students can opt one MOOC having 2 credits. In 4th semester, evaluation of project work/ dissertation will be conducted at the end of the semester.
2. There shall be external university examination of 3 hour duration for each theory courses at the end of each semester, to be conducted after the completion of 80 working days.
3. Each theory shall have 3- 4 credits and practical course 2 credits.
4. Each theory question paper may contain ten short answer types of weightage 1, four short essays out of 6 questions of weightage 5and two long essays out of 4 questions of weightage 10.
5. Each practical examination is of 3 hour duration and shall carry 2 credits each. Attendance carries weightage 10, Lab performance weightage 20, Tests weightage 50 and Record weightage 20.
6. Project/dissertation evaluation and viva-voce shall be conducted at the end of theprogramme only. Project / dissertation, and viva voce shall carry 20 credits in total.
7. Combined field studies and study tours may be carried out at any time during the entire period of the programme.

EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts (a) Internal/Continuous evaluation and (b) external evaluation. 50% marks shall be given to internal evaluation and the remaining 50% to external evaluation.

Internal evaluation: The internal evaluation shall be based on pre-determined transparent system

involving periodic written tests, assignments, seminars and attendance in respectof theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weightage assignedto various components for internal evaluation is as follows.

Components of Internal Evaluation

	Component	Weightage
A	Assignment	10
B	Seminar	5
C	Attendance	5
D	Class room participation	5
D	Test	25

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal grade.

The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the Director of the School.

External evaluation: The external Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably in a Centralized Valuation Camp.

EVALUATION OF PROJECT REPORT/ DISSERTATION

In the fourth semester students need to do project work of 6 month duration, which can be done either at KUFOS or at any other scientific institutions/ university/ researchcentres. The project has got internal as well as external evaluation. The project will be evaluated by a committee consisting of the head of the department, internal examiner/ guide and an external examiner appointed by university authorities. The mark for internal examination is 150 and external mark is also 150 with total of 300 marks for project. Total credits allocated for the dissertation is 20. Distribution of weightage allotted for dissertation will be as follows

Internals		Externals	
Originality	25%	Project Evaluation	50%
Presentation	50%	Presentation	50%
Report	25%		

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK

A high priority task in the context of future education development agenda in India is fostering quality higher education. Further improvement of quality of higher education is considered critical for enabling effective participation of young people in knowledge production and participation in the knowledge economy, improving national competitiveness in a globalized world and for equipping young people with skills relevant for global and national standards and enhancing the opportunities or social mobility. Sustained initiatives are required for institutionalizing an outcome-oriented higher education system and enhancing employability of graduates through curriculum reform based on a learning outcomes-based curriculum framework, improving/upgrading academic resources and

learning environment, raising the quality of teaching and research across all higher education institutions; technology use and integration to improve teaching-learning processes and reach a larger body of students through alternative learning modes such as open and distance learning modes and use of MOOCs.

Other priority areas of action for fostering quality higher education include translation of academic research into innovations for practical use in society and economy, promoting efficient and transparent governance and management of higher education system, enhancing the capacity of the higher education system to govern itself through coordinated regulatory reform and increasing both public and private sector investment in higher education, with special emphasis on targeted and effective equity-related initiatives.

The overall objectives of the learning outcomes-based curriculum framework are to:

- help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;
- enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values) or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study;
- maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility; and
- provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards

TEACHING - LEARNING PROCESS

The Learning Outcomes-Based Approach to curriculum planning and transaction requires that the teaching-learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. The outcomebased approach, particularly in the context of undergraduate studies, requires a significant shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies. Planning for teaching therein becomes critical. Every programme of study lends itself to well-structured and sequenced acquisition of knowledge and skills. Practical skills, including an appreciation of the link between theory and experiment, will constitute an important aspect of the teaching-learning process. Teaching methods, guided by such a framework, may include: lectures supported by group tutorial work; practicum and field-based learning; the use of prescribed textbooks and e-learning resources and other self-study materials; open-ended project work, some of which may be team-based; activities designed to promote the development of generic/transferable and subject-specific skills; and internship and visits to field sites,and industrial or other research facilities etc.

ASSESSMENT METHODS

A variety of assessment methods that are appropriate to a given disciplinary/subject area and a programme of study will be used to assess progress towards the course/programme learning outcomes. Priority will be accorded to formative assessment. Progress towards achievement of learning outcomes will be assessed using the following: time-constrained examinations; closed-book and open-book tests; problem based assignments; practical assignment laboratory reports; observation of practical skills; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva voce interviews; computerised adaptive testing; peer and self assessment etc. and any other pedagogic approaches as per the context.

AIMS OF THE MASTER'S DEGREE PROGRAMME IN MARINE CHEMISTRY

The overall aims of master's degree programme in Marine Chemistry are:

- providestudents with learning experiences that help instill deep interests in learning various disciplines in marine sciences including marine chemistry, biogeochemistry,marine pollution, isotope geochemistry, instrumentation techniques etc.
- develop broad and balanced knowledge and understanding of key chemical concepts, principles, and theories related to chemistry;and equip students with appropriate tools of analysis to tackle issues and problems in the field of marine chemistry
- develop in students the ability to apply the knowledge and skills they have acquired to the solution of specific theoretical and applied problems in the area
- provide students with the knowledge and skill base that would enable them to undertake further studies in the subject and related areas or in multidisciplinary areas that involve chemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

PROGRAMME LEARNING OUTCOMES: MSc. MARINECHEMISTRY

After successful completion of two-year Masters programme in Marine Chemistry, the students should be able to

- Demonstrate (i) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the chemistry and its different subfields (analytical, inorganic, organic and physical), and its linkages with related disciplinary areas/subjects (ii)the procedural knowledge that creates different types of professionals in the field of marine chemistry and related fields such as chemical industry, teaching, research, environmental monitoring, etc; (iii) practical skills related to specialisation areas within marine chemistry as well within the subfields of chemistry (analytical, inorganic, organic and physical), and other related fields of study, including broader interdisciplinary subfields (life and environmental sciences);
- Demonstrate skills in seawater analysis; analyse the chemical properties, nutrients cycles and biogeochemical interactions of the ocean.
- Useskills required for the extraction, separation and identification of various organic compounds in the marine environment.
- Understand and use various instruments in the area of marine analytical chemistry such as HPLC, IR, NMR and other spectroscopic techniques in the identification of inorganic and organic compounds.
- Employchemical techniques relevant to academia, industry and government, and generic skills and global competencies, includingrelevant disciplinary knowledge and skills that enable students to undertake further studies in the field of Environmental Chemistry or multi-disciplinary areas involving chemistry, and apply standard methodology to the solution of problems in chemistry.
- Handle advanced analytical tools and softwares used in marine sample analysis to explain Marine Chemistry, Marine Pollution, Isotope geochemistry, Sediment chemistry and Diagenesis.
- Undertakehands on lab work and activities that help develop in students practical knowledge and skills, that are required for pursuing career various disciplines related to Oceanography and skills for working safely and competently in the laboratory;
- Recognize and appreciate the importance of the chemical sciences and its application in academic, industrial, economic, environmental and social contexts.

COURSE LEVEL LEARNING OUTCOMES

SEMESTER I:(Core subjects: Theoretical Chemistry, Organic Reaction Mechanism and Stereochemistry, Co-ordination Chemistry and Introduction to Marine Environment)

- Understand the theoretical and fundamental aspects of Quantum mechanics, Group theory chemical bonding and Molecular Spectroscopy.
- Provide the students the basic concepts in organic and physical organic chemistry, stereochemistry and conformational analysis
- Give the students a strong back ground in bonding in coordination compounds, theories in bonding, chemistry of lanthanides and actinides, bioinorganic chemistry and reaction mechanisms in coordination compounds.
- Provide the students a strong foundation regarding the marine Environment – focussing on the general aspects, estuaries, ocean floor and biology of the oceans.

SEMESTER II: (Core subjects: Thermodynamics, Synthetic Organic Chemistry and Chemistry of Natural Products, Molecular Spectroscopy and Marine Chemistry)

- The Course provides a deep insight into various aspects of classical and statistical thermodynamics.
- Demonstrate modern synthetic methods and synthetic strategies to learn the synthesis and bio-synthesis of natural products
- Give an introductive picture of theoretical aspects of spectroscopic techniques by focussing on the fundamentals.
- Provide students a fundamental understanding of the chemistry of the oceans – focussing on dissolved gases, major and minor elements, micro nutrients and organic compounds.

SEMESTER III:(Core subjects: Solution Chemistry, Kinetics and Photochemistry, Marine Natural Products, Instrumental Methods in Marine Chemistry and Marine Pollution)

- Familiarizes the students with various theories and mechanisms of Chemical Kinetics, Solution Chemistry and Photochemistry
- Deliver a fundamental knowledge about marine natural products, sources, classes, isolation and applications.
- Provide an understanding of the instrumental methods used in chemistry – with special focus on techniques applicable to marine analyses.
- Understand the types of pollution, categories of pollutants and monitoring strategies of marine pollution.

SEMESTER IV:

- Design research oriented project on particular context.
- Review the literature on slected topics and identify the recent advances in current research.
- Prepare the students to work as part of teams on multi-disciplinary projects.
- Design and conduct experiments, analyse and interpret data.
- Demonstrate the skill to write disseratation, and communication skill in presentation.

Kerala University of Fisheries & Ocean Studies

MSc. Marine Chemistry - Course Structure, Scheme & Syllabus

(Credit Semester System – 2020 Admission onwards)

I Semester

Course	Course Code	Course Title	L	Tutorial	P	Exam Duration	Internal (%)	External (%)	Credits
Core	MCH 2101	Theoretical Chemistry	4			3 hrs	50	50	**4**
Core	MCH 2102	Organic Reaction Mechanism and Stereochemistry	4			3 hrs	50	50	**4**
Core	MCH 2103	Co-ordination Chemistry	4			3 hrs	50	50	**4**
Core	MCH 2104	Introduction to Marine Environment	3	1		3 hrs	50	50	**3**
Practical	MCH 2105	Practical I - Quantitative Chemical Analyses			4	3 hrs	50	50	**2**
Practical	MCH 2106	Practical II – Separation and Synthetic Methods			4	3 hrs	50	50	**2**
Elective	MCH 2107 MCH 2108 MCH 2109	Surface Chemistry and Colloids Analytical Chemistry Atmospheric Chemistry	3			3 hrs	50	50	**3**
	Total Credits	**22**							

II Semester

Course	Course Code	Course Title	L	Tutorial	P	Exam Duration	Internal (%)	External (%)	Credits
Core	MCH 2201	Thermodynamics	4			3 hrs	50	50	4
Core	MCH 2202	Synthetic Organic Chemistry and Chemistry of Natural Products	4			3 hrs	50	50	4
Core	MCH 2203	Molecular Spectroscopy	3	1		3 hrs	50	50	3
Core	MCH 2204	Marine Chemistry	3	1		3 hrs	50	50	3
Practical	MCH 2205	Practical III – Environmental Analyses			4	3 hrs	50	50	2
Practical	MCH 2206	Practical IV – Physico-Chemical Methods			4	3 hrs	50	50	2
Elective	MCH 2207 MCH 2208 MCH 2209 MCH 2210	Biogeochemistry Isotope Geochemistry Environmental ImpactAssessment Paleo Oceanography	3			3 hrs	50	50	3

Open Elective	OST 2201	General Oceanography	3						3
	OST 2202	Environment and Biodiversity							
	OST 2203	Marine Biotechnology							
	OST 2204	Marine Drugs							
	OST 2204	Climate Change and Polar Science							
	OST 2206	IPR and GI							
	Total Credits	**24**							

III Semester

Course	Course Code	Course Title	L	Tutorial	P	Exam Duration	Internal (%)	External (%)	Credits
Core	MCH 2301	Solution Chemistry,							
		Kinetics and Photochemistry	3			3 hrs	50	50	3
Core	MCH 2302	Marine Natural Products	3			3 hrs	50	50	3
Core	MCH 2303	Instrumental Methods in Marine Chemistry	3	1		3 hrs	50	50	3
Core	MCH 2304	Marine Pollution	3	1		3 hrs	50	50	3
Practical	MCH 2305	Practical V - Physicochemical Methods			4	3 hrs	50	50	2
Practical	MCH 2306	Practical VI - Instrumental Techniques in Aquatic Analyses			4	3 hrs	50	50	2
Elective	MCH 2307	Marine Geochemistry	3			3 hrs	50	50	3
	MCH 2308	Polar Sciences							
	MCH 2309	Coastal Zone Management							
	MCH 2310	Science writing and IPR							
Open Elective	OST 2301	Coastal Oceanography	3			3 hrs	50	50	3
	OST 2302	Ornamental Fishes and Aquarium Management							
	OST 2303	Fundamentals of Molecular Biology							
	OST 2304	Instrumentation techniques							
	OST 2305	Marine Geology							
	OST 2306	Food safety and Quality Control							
MOOC									2
	Total Credits	**24**							

IV Semester

Course	Course Code	Course Title	L	P	Exam Duration	Internal (%)	External (%)	Credits
Core		Dissertation			3 hrs	50	50	20
Total Credits 20								
Total Credits for the whole Programme (22+24+24+20)			90					

SEMESTER I

MCH 2101: Theoretical Chemistry

Credits: 4

Module I Quantum Mechanics

Introductory Concepts (Failure of Classical mechanics – Uncertainty principle), the postulates ofquantum mechanics: Wave function postulate- well behaved functions, orthogonality and orthonormality. Operator postulate- Laplacian and linear operators. Angular momentum operators and commutators. Hamiltonian operator and its properties. Eigen value postulate eigen value equations and eigen functions. Expectation value postulate. Postulate of time dependent Shrodinger equation. SolutionofSchrodingerwaveequationforafreeparticle, particle on a ring, particle in1D box, particle in 3D box, separation of variables, degeneracy. One dimensional Harmonic oscillator- Complete solution. Hermite polynomials, recursion formula, features of the wave functions. Hydrogen like systems, wavefunctionsofhydrogenlikesystems.

Module IISymmetry and Groups

Symmetry and Character table: Symmetry elements and symmetry operation, Point groups,Multiplication of operations, Group multiplication table, Similarity transformation and classification of symmetry operation, Matrix representationofpointgroup.Reducibleand Irreduciblerepresentations.TheGreat Orthogonality theorem. Rules derived from GOT (proof not required). Setting up of character table of $C_{2v,}C_{3v}$ and C_{2h} groups. Direct product representations.

Module III Chemical Bonding

LCAO-MO theory- MO theory of H_2^+ and H_2.treatment of other homo diatomic molecules Li_2, Be_2, $B_{2,}$ C_2, N_2, O_2 and F_2. MO treatment of hetero diatomic molecules LiH, CO, NO and HF. Spectroscopic term symbols for homo diatomic molecules. Valance bond theory of H_2. Quantummechanical treatment of SP, SP^2 and SP^3 Hybridisation.

HMO theory of conjugated π-systems. Bond order and charge density calculations. Free valance. Application of HMO method to ethylene, allyl system, butadiene and benzene.

Module IV Fundamentals of Spectroscopy

Origin of spectra, regions of electromagnetic spectra and origin of spectra, intensity of absorption,influencing factors, Beer lamberts' law, signal to noise ratio, natural line width, Doppler broadening, Born Oppenheimer approximation, Basics of rotational, vibrational and electronic spectroscopy.

References

1. P.W. Atkins and J de Paula. Physical Chemistry, 9th edn., Oxford University Press, 2010
2. A.K. Chandra. Introductory Quantum Chemistry, 3rd edn., McGraw Hill, 1989.
3. C.N.Banwell. Fundamentals of Molecular Spectroscopy, 12th edn., Tata McGraw Hill,1992.
4. H.B. Gray. Electrons and Chemical Bonding, Benjamin, 1965.
5. R.S. Drago. Physical Methods in Inorganic Chemistry, Affiliated East West Press, 1965.
6. M.C. Day andJ.Selbin. Theoretical Inorganic Chemistry 3rd edn., Van Nostrand – Reinhold, 1976
7. J.E. Huheey, E.A.Keiter, and R.L.Keiter. Inorganic Chemistry – Principles of Structure and Reactivity, Harper Collins College Publ., 1993.

MCH 2102: Organic Reaction Mechanism and Stereochemistry

Credits: 4

Module I Basic Concepts in Organic Chemistry

Review of basic concepts in organic chemistry: bonding, hybridisation, MO picture, inductiveeffect, electromeric effect, resonance effect, hyper conjugation, steric effect. Concept of aromaticity: delocalization of electrons - Hückel's rule, criteria for aromaticity, examples of neutral and charged aromatic systems - annulenes. Anti- and homo-aromatic systems- Fullerenes, Carbon nanotubes and Graphene. Mechanism of electrophilic and nucleophilic aromatic substitution reactions with examples. Arenium ion intermediates. SN1, SN2 and Benzyne mechanisms.

Module II Physical Organic Chemistry

Energy profiles. Kinetic versus thermodynamic control of product formation, Hammondpostulate, kinetic isotope effects with examples, Hammet equation, Taft equation. Catalysis by acids and bases with examples from acetal, cyanhydrin and ester formation and hydrolysis reactions-AAC2, AAC1, AAL1, BAC2 and BAL1 mechanisms. Solvent effect. Bulk and specific solvent effects. Introduction to carbon acids, kinetic and thermodynamic acidity. Hard and soft acids and bases - HSAB principle and its applications. Photoreactions of carbonyl compounds: Norrish reactions of ketones. Paterno- Buchi reaction, Barton, Di-π-methane and photo Fries rearrangements.

Module III Stereochemistry of Organic Compounds

Introduction to molecular symmetry and chirality – examples from common objects tomolecules, Centre of chirality – molecules with C, N, S based chiral centres, Absolute configuration, enatiomers, diastereomers, racemic modifications, R and S nomenclature using Cahn -Ingold – Prelog rules.

Axial, planar and helical chirality with examples, stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, ansa and cyclophanic compounds, spiranes, exocyclic alkylidenecycloalkanes. Topicity and prostereoisomerism.

Geometrical isomerism: E-Z nomenclature, methods of determination of geometrical isomers, Interconversion of geometrical isomers.

Module IV Conformational Analysis

Conformational descriptors factors affecting conformational stability of molecules. Conformational analysis of acyclic and cyclic systems – substituted ethanes, cyclohexane and its derivatives, Fused and bridged bicyclic systems – decalins, adamantane, norbornane.

Conformation and reactivity of elimination – dehalogenation, dehydrohalogenation, semipinacolic determination, pyrolytic elimination – Saytzeff and Hoffmann eliminations substitution and oxidation of secondary alcohols; Chemical consequences of conformational equilibrium – Curtin Hammett principle.

References

1. E.L. Eliel, S.H.Wilen, Stereochemistry of Organic Compounds, John Wiley &Sons,1994.
2. F.A. Carey, R.A. Sundberg, Advanced Organic Chemistry, Part A: Structure and Mechanisms, 5thEdn., Springer, 2007.
3. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2004.
4. D. Nasipuri, Stereochemistry of Organic Applications, 3rdEdn., New Age Pub., 2010.
5. P.S.Kalsi: Stereochemistry, Conformation and Mechanism, 7thEdn., New Age Publ., 2008
6. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanisms, Academic Press, 2002.
7. J. March, M.B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6thEdn., Wiley, 2007.
8. P.J, Grratt, Aromaticity, John Wiley & Sons Incorporated, 1986
9. D.G. Morris, Stereochemistry, RSC, 2001.
10. A. Fleming, Frontier Orbitals and Organic Chemical Reactions, Wiley, 1976.
11. S. Sankararaman, Pericyclic Reactions-A Text Book, Wiley VCH, 2005.
12. L. Kuerti, B.Czako, Strategic Applications of Named Reactions in Organic Synthesis, Elsevier Academic Press, 2005.

MCH 2103: Coordination Chemistry

Credits: 4

Module I Bonding in coordination compounds

Structure of coordination compounds with coordination number 1 to 8; examples of highercoordination numbers; isomerism in coordination compounds, chelate effect.VSEPR Theory**:** Valence Shell Electron Pair Repulsion Theory-stereochemical rules and explanation of the shapes of molecules and ions of non-transition elements with 2-7 valence shell electron pairs.

Module II Metal-ligand bonding in transition metal complexes

Crystal field splitting diagrams in complexes of low symmetry; ligand field theory, molecularorbital theory of octahedral complexes, Spectrochemical and Nephelauxetic series; thermodynamic and structural effects; site selection in spinels, Jahn-Teller effects and distortions; experimental evidence for metal-ligand orbital overlap; Limitation of crystal field theory, molecular orbital theory.

Module III Lanthanides and Actinides

Spectral and magnetic properties, Term symbols of Lanthanide ions, Use of lanthanide compounds as Shift reagents.Comparative evaluation of co-ordination chemistry of lanthanidesand actinides with reference to electronic spectra and magnetic properties.

Module IV Bioinorganic Chemistry

Metal ions in Biology, Molecular mechanism of ion transport across membrane ,ionophores , photosynthesis, PSL, PSH, nitrogen fixation, oxygen uptake proteins, cytochormes and ferrodoxins.

Module V Reaction mechanism

Reaction mechanism in coordination compounds; thermodynamic and kinetic stability,equilibrium constants, formation constants, lability, inert complexes, kinetics of substitution reactions in octahedral and square planar complexes, trans effect – theories of trans effect, atom transfer reactions; electron transfer reactions- inner sphere mechanism- Taube mechanism, outer sphere mechanism - Marcus equation.

References

1. J.E. Huheey, E.A. Keiter and R. L. Keiter. Inorganic Chemistry: Principles of structure and reactivity, 4th Edition, Addison Wesley Publ. Co., 1993 (Chapter 11, 12, 13 and 15).
2. F.A. Cotton, G.Wilkinson and P.L. Gaus. Basic Inorganic Chemistry, 3rd Ed., John Wiley 1995.
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Ed. Wiley Eastern, New Delhi, 1999 (4th and 5th eds. preferred)
4. D.F. Shriver and P.W. Atkins. Inorganic Chemistry, 5th Ed., Oxford University Press, 2010
5. D. Banerjea. Coordination Chemistry, 3rd Ed, Tata McGraw – Hill, New Delhi. 2009
6. N.N. Greenwood and A. Earnshaw. Chemistry of the Elements, 2nd Ed. Pergamon Press, Exeter, Great Britain, 1997.
7. J.D. Lee. Concise Inorganic Chemistry, 5th Ed. Chapman and Hall, 1996.
8. G. Rodgers. Introduction to coordination, solid state and descriptive Inorganic chemistry, 3rd Ed. McGraw–Hill, 2012.
9. Bodie Douglas, Darl McDaniel and John Alexander. Concept and Models of Inorganic Chemistry, 3rd Ed. J Wiley, 2006.
10. P. Atkins, T.Overton, J.Rourke, M.Weller and F. Armstrong. Shriver and Atkins Inorganic Chemistry, Oxford University Press, 2006.11. Sutton, D. Electronic Spectra of Transition Metal Complexes, McGraw-Hill: New York,1968
12. Mabbs, F.E. and Machin, D.J. Magnetism and Transition Metal Complexes Chapman and Hall: U.K, 1973.

MCH 2104: Introduction to Marine Environment

Credits: 3

Module I General Introduction

Dimensions of ocean, Physicalproperties of Seawater, Sea Water Density, CompressibilityEffects, Water Column Stability, T - S Diagrams, Surface Density Distributions, Horizontal, Vertical and Seasonal Temperature Distributions, Surface Salinity Distributions, Vertical Profiles of Salinity, Vertical Distribution of Density, Sound Transmission in the Sea, tides and tidal currents in shallow seas, estuaries and rivers.

Module II Estuaries

Classification and nomenclature; tides in estuaries; estuarine circulation and mixing; depth –averaged and breadth – averaged models; sedimentation in estuaries; salinity intrusion in estuaries; effect of stratification; coastal pollution; mixing and dispersal of pollutants in estuaries and near-shore areas; coastal zone management.

Module III The Ocean floor

General topography of the ocean floor, continental shelves, slopes, submarine canyons, submarine ridges and trenches. Morphologic and tectonic domains of the ocean floor. Structureand composition of oceanic crust - hydrothermal vents- chemical and biological significance of

hydrothermal vents systems. Ocean margins and their significance; geochronology of oceanic sediments, Mineral resources.

Module IV Sea as a Biological Environment

Classification of the marine environment and marine organisms – plankton, nekton, benthos –marine ecosystems, marine food web, trophic structure - primary and secondary production and factors influencing them. Physico-chemical factors affecting marine life – light, temperature, salinity, pressure, nutrients, dissolved gases; adaptation and biological processes.

Module V Marine Ecology

Nekton and fisheries oceanography, Benthic organisms; coastal marine communities andcommunity ecology – estuaries, coral reefs and mangrove communities, deep-sea ecology including hydrothermal vent communities.

References

1. J. W. Nybakken, Marine Biology – An Ecological Approach, 5thEd., Addison WesleyLongman Inc., 2001.
2. A. C. Duxbury, A. B. Duxbury, K. A. Sverdrup, An Introduction to World Oceans, 6th Ed., McGraw-Hill, 2000.
3. E. P. Odum, Fundamentals of Ecology, Nataraj Publishers, 1996.
4. T. Garrison, Oceanography, 2nd Ed., Wadsworth Publishing, 1995.

MCH 2105 Quantitative Chemical Analyses (Practical)

Credits: 2

1. Separation and estimation of simple binary mixtures of metal ions in solutions
2. Titrimetric estimations:
   1. Complexometric titrations using EDTA for the estimation of Ca, Mg, Zn, Ni, hardness of water.
   2. Redox titrations with ceric sulphate, dichromate and permanganate for the estimations of ferrous iron, zinc, arsenous oxide and sodium oxalate.
3. Estimations of
   1. Phenol, salicylic acid, aspirin, aniline and sulphanilic acid (Bromate-bromide method)
   2. Glucose and sucrose (Fehling's method)
   3. Acids and esters in a mixture
   4. Carboxylic acids and carboxylic groups (iodometric method)
   5. Iodine value and saponification value of vegetable oils
   6. Estimation of Nitrogen (Kjeldhal's method)

References

1. J.Bassett, R.C.Denney,G.H. Jeffery and J. Mendham. Vogel's Text Book of Quantitative Inorganic Analysis, 5th edn. Longman Scientific and Technical, 1989.
2. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R Tatchell. Vogel's textbook of Practical Organic Chemistry, 5thedn, Longman Scientific and Technical, 1989
3. Mann and Saunders. Practical Organic Chemistry,4th edn, Orient Longman, 2004.
4. F.J. Welcher, Standard Methods of Chemical Analysis: Vol. 2, R.E. Kreiger Pub., 2006.

5. G. Pass, H. Sutcliffe, Practical Inorganic Chemistry, Chapman & Hall, 1974.
6. J.R. Adams, J.R. Johnson, J.F. Wilcox, Laboratory Experiments in Organic Chemistry, Macmillan, 1979.
7. I.M. Koltoff, E.B.Sandell, Text Book of Quantitative Inorganic analysis, 3rdEdn., McMillian, 1968.

MCH 2106 Separation and synthetic methods (Practical)

Credits: 2

1. Separation and Identification of organic binary mixtures
    1. Separation of components by physical and chemical methods
    2. Purification of components by suitable method
    3. Characterization of functional groups, if any, by systematic analysis
    4. Preparation and purification of solid derivative
    5. Determination of physical constants
2. Preparation of organic compounds involving nitration, sulphonation, halogenisation oxidation, diazotisation, Friedel – Crafts reaction, Claisen condensation, Grignard reaction, benzoin condensation, Benzilic acid rearrangement and catalytic hydrogenation
3. Chromatographic techniques : Column Chromatography, Paper chromatography, Thin layer chromatography
4. Synthesis and Characterization (Metal content and interpretation of IR and electronic spectra) of Inorganic complex compounds (common transition metals and common oxygen, nitrogen or sulphur donor ligands organometallic compounds.

References

1. J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham. Vogel's Text Book of Quantitative Inorganic Analysis, 5th edn., Longman Scientific and Technical, 1989
2. A.I. Vogel. Practical Organic Chemistry, ELBS, 1994
3. Mann and Saunders. Practical Organic Chemistry,4thedn, Orient Longman, 2004
4. G. Pass and H. Sutcliffe. Practical Inorganic Chemistry 2nd edn., Science Paperbacks,1985
5. K. Nakamoto. Infrared and Raman Spectra of Inorganic and Coordination Compounds 6th edn. Wiley-Interscience, 2009.
6. J.R. Adams, J.R. Johnson, J.F. Wilcox, Laboratory Experiments in Organic Chemistry, Macmillan, 1979.
7. F.J. Welcher, Standard Methods of Chemical Analysis: Vol. 2, R.E. Kreiger Pub., 2006

MCH 2107 Surface Chemistry and Colloids

Credits: 3

Module I Surface Chemistry:

Different types of surfaces. Properties of surface phase. Thermodynamics of surface. Examination of surfaces using ESCA, Auger, SEM and STM.Surface tension of solutions. Gibb's adsorption equation and its verification.Surfactants and miscelles. Surface films: different types, Surface pressure and Surface potential, and their measurements and interpretation. The Gas- solid inter phase. Types of adsorption. Heat of adsorption, The Langmuir theory kinetic and statistical derivation. Multilayer adsorption- the BET theory and Harkins- Jura theory.

Module II Surfactants:
Structure of surfactants in solution; critical micellation concentration (CMC); temperaturedependence; influence of chain length and salt concentration; surfactant parameter. Emulsions: macro- and micro-emulsions; aging and stabilization of emulsions; Phase behaviour of micro emulsions. Vesicles, lipid bilayer membrane.

Module III Colloids:
Types of colloids, Stability and zeta potential, Properties of colloids, Kinetic, optical and electrokinetic properties. Electrophoresis, Electro osmosis, spontaneous aging of colloids, Coagulation or flocculation, Donnan membrane equilibrium and its applications.

References:

1. P.W. Atkins, Physical Chemistry, ELBS, 1994.
2. D.A. McQuarrie, J.D. Simon, Physiacl chemistry: A Molecular Approach, University Science Books, 1997
3. A.W. Adamson, A.P. Gast, Physical Chemistry of Surfaces, 6th Edn., John Wiley & sons, 1997.

MCH 2108 Analytical Chemistry

Credits: 3

Module I Vacuum and Gas Pressure
Concepts of vacuum (Low, medium, high and ultra-high vacuum; vacuum pumps and gauges;pressure measurements;); kinetic theory concepts (molecular density; mean free path of particles in the gas phase; incident molecular flux on surfaces; gas exposure; sticking coefficient; surface coverage; variation of parameters with pressure).

Module II Over layers and Diffraction
Two-dimensional lattice; reciprocal space; over layer structure; low energy electron diffraction(LEED).

Module III Imaging and Depth Profiling
Basic concepts in surface imaging; Secondary Electron Microscopy (SEM); Secondary AugerMicroscopy (SAM); Scanning Probe Microscopy (SPM); Scanning Tunneling Microscopy (STM); Transmission Electron Microscopy (TEM); surface imaging; depth profiling. Associated techniques of microscopy and spectroscopy.

Module IV Chemical Analysis
Non-destructive techniques: Wavelength and energy dispersive X-ray fluorescencespectroscopy (WDS and EDS); X-ray absorption spectroscopy (XANES and EXAFS); secondary ion mass spectrometry (SIMS); temperature programmed desorption (TPD); thermal desorption spectroscopy (TDS). Destructive techniques: Atomic absorption spectroscopy (AAS); inductively coupled plasma-atomic emission spectroscopy (ICP-AES).

Module V Electro analytical Techniques
Voltametry; Coulometry; Amperometry; Potentiometry; Polarography; Electrolyticconductivity; Impedance spectroscopy.

References: -

1. R. Wiesendanger, Scanning Probe Microscopy and Spectroscopy, Cambridge University Press, 1994.
2. Frank A.Settle, Handbook of instrumental techniques for analytical chemistry, Prince Hall, New Jersey, 1997.
3. K. W. Kolasinski, Surface science: Foundations of catalysis and nanoscience, John Wiley and Sons, West Susses, 2002.
4. D. A. Skoog, D. M. West, F. J. Holler and S. R. Couch, Fundamentals of analytical chemistry. Brooks/Cole Cengage learning, New Delhi, 2004.
5. P. Atkins and J. de Paula, Atkins' physical chemistry, 8th Ed., Oxford University Press, New Delhi, 2008.
6 T. Pradeep, Nano: The essentials, McGraw-Hill Education, New Delhi, 2010.
7 F. Scholz, Electro analytical Methods, Springer, 2nd Ed., 2010.

MCH 2109 Atmospheric Chemistry

Credits: 3

Module I Introduction

Gas laws and properties, black body radiation and radiation laws -Atmospheric Composition andStructure: Chemical composition of earth's atmosphere Major and minor constituents, Vertical structure, Lifetimes, radiation balance – Carbon, Oxygen, Nitrogen and Sulphur cycles. of the Atmosphere – temperature regulation in the thermosphere, stratosphere and troposphere. Radiation balance and Green houseeffect, global warming- climate past and future.

Module II Fundamentals of Atmospheric Chemistry

Biogeochemical cycles of Carbon, Oxygen, Nitrogen and Sulphur cycles, halogen and traceelement cycles- Photochemical processes – photo dissociation and ionisation, Reactions of electronically excited species, Chemical kinetics – Unimolecular, bimolecular, and termolecular reactions. Condensed-phase, surface and heterogeneous reactions.

Module III Atmospheric Aerosols

Sources, sinks and physical and chemical properties, Formation, growth and transformations ofaerosols, Aerosol-cloud interactions, Stratospheric Aerosols, Aerosol climate feedbacks

Module IV Stratospheric Chemistry

Chapman model, Hox, Nox, CIox cycles, chemical mechanisms of polar ozone depletion,Anthropogenic impacts: Oxygen only chemistry, reaction scheme, Chapman layers. Influence of trace constituents – catalytic cycles, Null cycles, holding cycles and reservoirs, natural sources and sinks of catalytic species. Heterogeneous and homogenous chemistry. Consequences of ozone perturbation, ozone variations and trends.

References

1. R.P. Wayne. Chemistry of Atmospheres, Oxford University Press (2000)
2. P.V. Hobes. Introduction to Atmospheric Chemistry, Cambridge University Press (1999)
3. Nigel Bunce Environmental Chemistry, WuerzPublising Ltd. (1991).
4. Jacob, Daniel. Introduction to Atmospheric Chemistry . Princeton University Press, 1999
5. Seinfeld J.H and Pandis S.N, Atmospheric Chemistry and Physics ,2ndEd.,John Wiley and Sons,Inc.,2006

SEMESTER II

MCH 2201: Thermodynamics

Credits: 4

Module I Classical Thermodynamics
Extensive and intensive properties - state functions and path functions - types of processes - Zeroth law of thermodynamics. internal energy and enthalpy, Joule-Thomson effect –second law of thermodynamics - spontaneous processes - Entropy: Definition –entropy a state function - Third law of thermodynamics: Nernst heat theorem.

Module II Spontaneity and Equilibrium
Condition for equilibrium and spontaneity under constraints, Driving force for natural changes. The properties of A and G,Gibbs energy of real gases, temperature dependence of the Gibbs energy

Module III Irreversible Thermodynamics
Simple examples of irreversible processes. General the oryofnon- equilibrium processes. Entropy production from heat flow. Matter flow and current flow. The phenomenologicalrelations.Onsagerreciprocalrelation,Applicationofirreversiblethermodynamicsto diffusion.Thermaldiffusion,Thermoosmosisandthermomolecularpressuredifference, electrokinetic effects, the Glansdorf- Prigogine equation. Far from equilibrium region. Principleofminimumentropyproduction.Thermodynamicanalysisofstability.Stability criterion and Le-Chatelier Braun Principle.

Module IV Statistical Thermodynamics
Microstates. ConceptofensembleCanonicalandGrandCanonicalensemble. Maxwell Boltzmann distribution.Quantumstatistics:BoseEinsteinStatistics,Thermodynamic probability, Fermi- Dirac Statistics, RelationbetweenMaxwellBoltzmann,BoseEinstein andFermi-Dirac Statistics The Partition functions. Partition function for free linear motion, for free motion in a shared space, for linear harmonic vibration. Complex partition functions and partition function for particles in different force fields. Langevin's partition function and its use for the determination of dipole moment.

Module V Bioenergetics
Coupled reactions, ATP and its role in bioenergetics, high energy bond, free energy andentropy change in ATP hydrolysis, thermodynamic aspects of metabolism and respiration, glycolysis, biological redox reactions.

References
1. C. Kalidas, M.V.Sangaranarayanan. Non-equilibrium thermodynamics, MacmillanIndia, 2002
2. K.M. Botham, D.K Granner, P. A. Weil, D. Bender and V.W. Rodwell. Harper's Illustrated Biochemistry, Tata McGraw Hill, 2015.
3. Tinoco, K.Sauer, J.C.Wang and J.D. Puglisi. Physical Chemistry: Principles and

Applications in Biological Science, 5th edn, Prentice Hall, 2013
4. F.W. Sears and G.L. Salinger.Thermodynamics, kinetic theory and statistical thermodynamics, 3rd edn, Addison Wesley, 1998.
5. J. Kestin, and J.R. Dorfman.A course in Statistical Thermodynamics, Academic Press, 1971.
6. P.W. Atkins and J de Paula. Physical Chemistry, 9thedn., Oxford University Press,2010
7. F.W. Sears. Thermodynamics, Kinetic Theory of Gases and Statistical Thermodynamics, 3rd edn, Addision Wesley, 1978.
8. G.W. Castellan. Physical Chemistry, 3rdedn, Addison Wesley, 1983
9. F. Daniels and R.A. Alberty. Physical Chemistry 6th edn., John Wiley, 1984
10. T.L. Hill. Statistical Thermodynamics, Addison Wesley, 1986.

MCH 2202: Synthetic Organic Chemistry and Chemistry of Natural Products

Credits: 4

Module I Alkaloids and Bio Organic Chemistry

Total synthesis of quinine, morphine and reserpine. Nucleic Acids: types of nucleic acids - DNA& RNA polynucleotide chain. Components - biological functions. Structure and role of (genetic code) DNA and RNA (Nucleotides only) Biosynthesis of Cholesterol

Module II Proteins

Peptides and their synthesis - synthesis of tripeptide. Merrifield synthesis, Determination oftertiary structure of proteins, Bio-synthesis of proteins.

Module III Modern Synthetic Methods, Reactions and Reagents

Principles and synthetic processes involving phase transfer catalysis, (Nitriles from Alklyhalides, Alcohol from Alkyl halides) polymer supported reagents (synthesis of oligo saccharides), (micro oven, esterification, deacetification and hydrolysis).

Synthesis of simple organic molecules using standard reaction like acetylation alkylation of enamines and active methylene compounds, Grignard reactions, Phosphorus and sulphur ylides Robinson annulation, Diels Alder reactions, protection and deprotection of functional groups (R- OH, R-CHO, RCO-R, R-NH2 and R-COOH).

Uses of the following reagents: DCC, Trimethylsilyliodide, 1, 3-Dithiane (umpolung), diisobutylaluminimumhydride (DIBAL), 9BBN, Trimethylsilylchlorode.

Module IV Planning Organic Synthesis and Retrosynthetic Analysis

(Synthesis of the following target molecules: longifolene, cubane, 5-hexenoic acid, trans-9-methyl I-decalone, bicyclo (4,1,0) heptan-2 one and onocerin.

An introduction to retrosynthesis - Synthon, Synthetic equivalent, Target molecule, Functional group interconversion - Disconnection approach - One group disconnection - Disconnection of alcohols, olefins and ketones - Logical and illogical disconnections, Two group disconnection -

1,2 - 1,3 - 1,4 - 1,5 - and 1,6 - deoxygenated skeletons and dicarbonyls. Retro Diels Alder reaction - pericyclic reactions - Retrosynthesis of some heterocycles containing two nitrogen atoms.

Module V Heterocycles, Vitamins and Steroids

Imidazole, oxazole, thiazole, flavones, isoflavones, anthocyanins, pyrimidines (cytocine andUracil only) and purines (adenine.Guanine only). Synthesis of parent and simple alkyl or aryl

susbstitutionderivatitives are expected. Synthesis of vitamin A1 (Reformatsky and Wittig reaction methods only).Conversion of cholesterol to progesterone, estrone and testosterone.

References:

1. Guide book to Organic synthesis by Ramond K. Mackie and David M. Smith, ELBSPublication.
2. Chemistry of alkaloids by Pelletier.
3. Introduction to Alkaloids by G.A. Swan
4. Organic Chemistry V Edition, 1986, VolII by I.L. Finar, ELBS Publication
5. Outlines of Biochemistry V Edition by Eric E. Conn, Paul. R. Stumpf, George Bruening and Roy H. Dole, John Wiley and Sons.
6. Principles of Biochemistry General aspects by L. Smith, Robert L. Hill I. Robert Lehman, Robert J. Let Rowitz, Philip Handlar and Abrahim white. McGraw Hill Int. (7th Edition)
7. Biochemistry by LubertStryer, WH. Freeman and Co., New York
8. Chemistry of organic natural products by Agarwal, Geol Publishing House.
9. Organic synthesis by R.E. Ireland, Prentice Hall of India, Geol Publishing House.
10. Principles of Organic synthesis by R.O.C. Norman, Champan and Hall, NY, 1980.11. Advanced Organic Chemistry by Francis. A. Carey Richard J.Sundberg, 3rd Edition, Plenum, Press, New York, 1990.
12. Advanced Organic Chemistry by Jerry March, IV edition Wiley Eastern Ltd., NewDelhi.
13. Organic Chemistry, 6th Edition, 1992. RT.Morrison, R.S. Boy, Prentice Hall of IndiaPvt. Ltd., New Delhi.
14. Micheal B. Smith, Organic Syntheis, McGraw Hill, International Editor, 194.
15. Stuart Warren, Work book for organic synthesis, The Disconnection Approach JohnWiley & Sons (Asia) Pvt. Ltd.,
16. W. Carruther, Jain Coldham, Modern Methods of organic synthesis, 4th Edition

MCH 2203: Molecular Spectroscopy

Credits: 3

Module I Vibrational spectroscopy

Infrared Spectroscopy, interpretation of infrared spectra, functional group absorptions, FT-IR advantages and disadvantages, Near & far IR spectroscopy , applications of IR spectroscopy.

Module II Raman spectroscopy

Classical and quantum theory, Comparison of IR and Raman spectra – complementary natureand mutual exclusion principle, applications of Raman spectroscopy.

Module III Ultraviolet/Visible/Fluorometric Spectroscopy

Energy level and selection rules; effect of substituents, conjugation, conformation and geometry;Woodward-Fisher& Fisher-Kuhn rules, applications in structure determination; Derivative spectroscopy, Fluorescence spectroscopy, factors affecting fluorescence & intensity; applications.

Module IV Resonance Spectroscopy

Nuclear Magnetic Resonance-1H-NMR spectroscopy- chemical shifts, diamagnetic shielding, hybridization effects, magnetic anisotropy, mechanism of spin-spin coupling, the origin of spin-
Spinsplitting, Pascal's triangle, coupling constant, magnetic equivalence, failure of the N+1 rule,

Theory of Chemical shift and spin – spin coupling, AB, AX, ABC, AMX patterns; chemical shift reagents, spin decoupling methods, Nuclear Overhauser Effect (NOE) , Introduction to 1H-1H cosy and its applications. Introduction and applications of 2D NMR; solid state NMR, magnetic imaging.
13C-NMR spectroscopy: Introduction, Chemical shift, peak assignments, 1H decoupled spectra (off resonance, selective 1H decoupling, 1H noise decoupling); chemical shift; chemical shift equivalence; Hetero 2D NMR techniques: HMBC, HMQC.
Spectrometry of other important nuclei Introduction to 15N, 19F, 31P, basic concepts.
Electron Spin Resonance Spectroscopy- Introduction, derivative curves, g values, hyperfine splitting, ESR spectra of free radicals, applications.

Module VI Mass Spectrometry, CD & ORD
Basic principle and theory; Analysis of mass spectrum, HRMS and advantages spectra ofrepresentative compounds, recognition of molecular ion peak, metastable peak, isotopic peaks, applications.
Optical Rotatory Dispersion and Circular Dichroism Definition, cotton effect and stereochemistry, octant rule and applications.

References

1. Silverstein RM and Webster FX. Spectrometric Identification of Organic Compounds.John Wiley and Sons, New York. Latest Edition.
2. Chatten LG. Pharmaceutical Chemistry, Vol. I & II. Marcel Dekker, New York. Latest Edition.
3. James WD and Kenneth HT. Analytical Chemistry byOipen Learning: ThermalMethods. John Wiley and Sons, New York. Latest Edition.
4. Abraham RJ, Fisher J and Bftus P. Introduction to NMR Spectroscopy. John Wiley and Sons, New York. Latest Edition.
5. Pavia DL, Lampman GM and Kriz GS. Introduction to Spectroscopy. Harcourt College Publishers, Orlando. Latest Edition.
6. Atta-Ur Rahman's volumes on Natural products and spectroscopy.

MCH 2204: Marine Chemistry

Credits: 3

Module I Ocean as a Chemical System
History of oceanography, important oceanographic expeditions and oceanographic institutions ofthe world. 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.

Module II Classification of elements based on their distribution
Composition of sea water, salinity and chlorinity concepts, the major and minor constituents,constancy of relative composition, behavior of elements - chemical exchanges across interfaces and residence times in seawater, geochemical balance of oceans. Primary, cosmogenic and artificial nuclides, Applications of radioisotopes in oceanography

Module III Dissolved gases in sea water
Factors affecting the concentration of gases in seawater, pH, alkalinity, specific alkalinity,buffer capacity, sea water - carbon dioxide equilibria, precipitation and dissolution of carbonates, global carbon cycle. Biological pump and controls on atmospheric composition - emission of greenhouse gases.

Module V Micronutrients
Nitrogen, phosphorus and silicon their cycles, distribution profiles and their effect onphytoplankton growth, N/P ratio.

Module VI Organic matter in the sea
Dissolved and particulate: Nature, origin and distribution, Photosynthesis and Primary production.

References

1. A. C. Duxbury, A. B. Duxbury, K. A. Sverdrup, An Introduction to World Oceans, 6th Ed., McGraw-Hill, 2000.
2. T. Garrison, Oceanography, 2nd Ed., Wadsworth Publishing, 1995.
3. F. J. Millero, Chemical Oceanography, 2nd Ed., CRC Press, 1996 or 3rd Ed., CRC Press 2006.
4. J. P. Riley, R. Chester, Introduction to Marine Chemistry, Academic Press, 1971.
5. Seawater: Its Composition, Properties and Behaviour, The Open University Oceanography Series, Pergamon, 2nd Ed., 1995.
6. J. P. Riley, G.Skirrow, Chemical Oceanography, Vols. I to III, Academic Press,1975.
7. K. Grasshoff, K.Kremling, M.Ehrhardt Ed., Methods of Seawater Analysis, 3rd completely revised and extended edition, Wiley-VCH, 1999.

MCH 2207 Biogeochemistry

Credits: 3

Module I Introduction, overview and concepts:
Major element cycles in the deep ocean, Mass balance between river input and oceanic sedimentoutputs for minor and trace elements.Oceanic circulation and chemistry, Biological Pump, Primary Production in the ocean, nutrient supply, Use of nutrients as water mass tracers, primary producers, seasonal cycles, spring bloom, nitrogen fixation. The Iron hypothesis, Elemental Stoichiometry and Redfield ratio. Influence of biota on the geochemical cycling of inorganic and organic substances through the atmosphere, hydrosphere, and lithosphere.

Module II Biogeochemical Cycles:
Biogeochemical cycles of carbon, nitrogen and sulfur. The oceanic carbonate system, globalocean-atmosphere interactions, biogeochemical cycles and climate change. Biogeochemistry of carbon, sulfur, selected metals, and organic compounds of natural and anthropogenic origin. The carbon cycle, The sulfur Cycle, Isotope effects – Mass dependent and mass independent effects, Isotope geothermometers, Isotope fractionation in the geochemical cycles of carbon and sulfur. Relations among isotope age curves, Stable isotope variations of Heavy elements, Si, P and Fe Biogeochemical cycles.

Module III Climate change effects/feedbacks on C-cycle:
Air-sea carbon dioxide fluxes, Ocean acidification and carbonate chemistry, Effect of oceanacidification on the speciation of metals in seawater, Benthic processes of biogeochemical cycles. UVR effects on aquatic ecosystem: a changing climate perspective.

References

1. Libes, S.M. (2009). Introduction to Marine Biogeochemistry. Elsevier, Amsterdam.
2. William H. Schlesinger and Emily S. Bernhardt, Biogeochemistry: An Analysis of

GlobalChange. Academic Press, 3rd Edition, 2013
3. Chemical cycles in the evolution of the earth. C.B. Gregor, R.M. Garrels, F.T. Mackenzie and J.B. Maynard.
4. Stable Isotope geochemistry, JochenHoefs (VI th Ed) Springer, 2009.
5. UV effects on aquatic organisms and ecosystems – E.W Helbling and H Zagarese(VolEdts)– Donat Peter Hader and GuilioJori, 2003.
6. Chemical Oceanography, Frank J Millero (4th Edn) CRC Press, 2013.

MCH 2208 Isotope Geochemistry

Credits: 3

Module I Introduction and Scope of Isotope geochemistry:
Concept of systems and equilibrium, thermodynamic variables, Equations of state, Energy and laws of thermodynamics, path independence, state functions and first law, entropy and second law, the third law and absolute entropy, Gibbs free energy, Helmholtz free energy

Module II Chemical properties and isotopic systematics:
Stable Isotope geochemistry, fractionation of isotopes, H, C, O and S; Stable Isotope Geochemistry - variations in the isotopic ratios of sulphur, carbon and oxygen, lithium and barium in geological systems.
Basics of stable isotope mass spectrometry, continuous flow and duel inlet methods, their accuracies, precision, resolving power and sensitivities, equilibrium and kinetic fractionations, vital effects.
Determination of sedimentation rates using radioisotopes, the radiocarbon method, and accelerator mass spectrometry. Dating of sediments, corals, tree rings: 210-Pb, C-14, U-Th.

Module III Applications in climate studies:
C-12, C-13, O-16, O-18, C, Mg, N and their ratios Stable isotopes and their applications to paleoclimate reconstruction - ice ages, causes of ice ages, Milankovitch Theory - cycles in eccentricity, precession and obliquity (tilt); foraminifera, oxygen and carbon isotopic variations in planktic and benthic foraminifera in marine sediment cores and corals.
Dating of past coral terraces and determination of paleo-sea level. Reconstruction of paleo-temperatures using Mg/Ca in foraminifera.Productivity, new production and their measurements using ^{14}C, ^{13}C and ^{15}N isotopes.

References:

1. A.P. Dickin (2000) Radiogenic Isotope Geology. Cambridge University Press, 490p.
2. Gunter Faure (1986) Principles of Isotope Geology, Wiley, New York
3. Hoefs, Jochen (2015) Stable Isotope Geochemistry, Springer
4. Todd E.Dawson & Rolf T.W. Seigwolf (2007). Stable Isotopes as Indicators of Ecological Change, Academic Press.
5. Mark Baskaran (Editor) 2011. Handbook of Environmental Isotope Geochemistry, Springer (2 volumes).
6. Heinrich D Holl & Karl Turekian (eds.) 2010. Isotope Geochemistry - A derivative of the Treatise on Geochemistry. Academic Press, p. 752.
7. William M. White (2014). Isotope Geochemistry, Wiley-Blackwell, 496 p.

MCH 2209: Environmental Impact Assessment

Credits: 3

Module I EIA Introductory Concepts:
Introduction to Environmental planning EIA process: evaluation of proposed actions: scoping EIAmethodologies Impact Assessment Methodologies: Measurement of environmental impact, EIA Models, role of GIS in EIA base line study.
Coastal Regulation Zone (CRZ): Coastal Regulation Zone (CRZ) Notification, 2011, Island Protection Zone (IPZ) Notification, 2011, Importance of CRZ Notification, Objectives, Limit of the CRZ Area, Allowed and not allowed activities in Coastal Zones, ICZMP.

Module II EIA Case studies:
River valley projects: thermal power plants: mining projects: oil refineries and petrochemicals:tourism coastal zone development, EIA Regulations in India.

Module III Generalized approach to impact analysis:
EIA guidelines 2006, Notification of Government of India Procedure for reviewing Environmentalimpact analysis and statement. Baseline information and predictions (land, water, atmosphere, energy etc.). Concept and strategies of sustainable development, Cost-Benefit analysis, Environmental priorities in India and sustainable development.
Guidelines for Environmental audit: Definitions and concepts, partial audit, compliance audit, methodologies and regulations, 1SO14000, Consumption audits, pollution audits, hazardous issues and its voluntary audits.

References

1. John Glasson, RikiTherivel, Andrew Chadwick (2005) Introduction to Environmentalimpact assessment. Taylor and Francis
2. Richard K. Morgan (2002) Environmental impact assessment: A methodological approach.Kluwer Academics
3. David P. Lawrence (2003) Environmental impact assessment: Practical solutions to recurrent problems. John Wiley & Sons
4. Canter Larry. Environment Impact Assessment, 2nd edn., McGraw Hill Science, 1995.
5. G.J. Rau, and C.D. Wooten. Environmental Impact Analysis Handbook, McGrawHill.Reference Book, 1980.
6. Glasson, John, Rikki Therievel and Andrew Chadwic. Introduction to Environmental ImpactAssessment, 4th edn., Routledge, 2012
7. Kulkarni, Vijay and T.V. Ramchandra. Environmental Management. The Energy andResources Institute (TERI), 2009
8. Eccleston, Charles H. Environmental Impact Assessment: A Guide to Best ProfessionalPractices, CRC Press, 2011.
9. Morris, Peter and RikiTherivel. Methods of Environmental Impact Assessment (Natural and Built Environment Series). Routledge, 2009.
10. P. Leelakrishnan. Environmental Law in India, 3rd edn., ButterworthsWadhwa, 2008.
11. Dwivedi, S.N., Natarajan, R and Ramachandran, S., "Coastal Zone Management in Tamilnadu".

MCH 2210: Palaeooceanography

Credits: 3

Module I Fundamentals of palaeoceanography :
Elements of climate, global climatic variation.Ocean's place in the climate system; Milankovitch theory of climate change.

Module II Approaches to palaeoceanography :
Global paleoceanographic evolution.Carbon, silica, phosphorus and nitrogen cycles and their evolution. Importance of palaeoceanographic studies for the modern chemical cycling and processes.

Module III Palaeoceanographic techniques, proxies and significance :
Concept of proxies in palaeoceanography – quantitative and qualitative proxies; Use of proxies for reconstruction of oceanic temperature, circulation, biological productivity, nutrient cycling, alkalinity, carbonate ion concentration, redox processes; Linear and non-linear oceanic responses to climate forcing.

References:

1. Thomas J. M. Schopf, Paleoceanography, Harvard University Press, 1980.
2. Fischer, Gerhard, Wefer, Gerold (Eds.), Use of Proxies in Paleoceanography, Springer-Verlag, 1999.
3. Fatima Abrantes , Alan Mix (Editors). Reconstructing Ocean History: A Window Into the Future, Springer, 2012
4. C. Hillaire-Marcel, Anne de Vernal (Editors), Proxies in Late CenozoicPaleoceanography: 1 (Developments in Marine Geology), Elsevier Science, 2007.

MCH 2205 Environmental Analyses (Practical)

Credits: 2

1. Sampling of water (microlayer, surface , sub-surface) and sediment (surficial and sub - surface)
2. Filtration and storage of samples.
3. Determination of salinity – Physical and Chemical methods.
4. Determination of DO- concept of A.O.U
5. Determination of BOD and COD.
6. Determination of pH – Spectrophotometric method.
7. Determination of alkalinity.
8. Determination of Eh.
9. Determination of nutrients – nitrite, nitrate, ammonia and phosphate – both water and sediment.
10. Determination of pigments (chlorophyll a, b, c and phaeopigments).
11. Determination of organic matter in water, sediment and particulates – TOC, POC andSOC.
12. Sample preparation, handling and determination of trace metals in environmental samples.

References

1. K. Grasshoff, M. Ehrhardt and K. Kremling. Methods of Seawater Analysis. 3Rd Edn.Wiley -VCH, 1999.
2. APHA, Standard Methods for the Examination of water and waste water, 22nd Edn. 2012.
3. IOC Manuals and Guides -12. Chemical methods for use in Environemntal Monitoring, UNESCO, 1983.
4. IOC Manuals and Gudes – 15. Procedures for sampling Sea Surface Micro – layer, UNESCO. 1985.
5. J.D. Strickland and T.R. Parsons. A Practical Handbook of Sewater Analysis, Unipub,1084.
6. T.R. Parsons, Y. Maita and C. M. Lalli. A manual of Chemical and Biological Methods for Seawater Analysis, Pergamon Press. 1984.

1. Phase diagram

MCH 2206Physico - Chemical Methods (Practical)

Credits: 2

1. Construction of Phase diagrams of simple eutectics
2. Effect of KCl/succinic acid on miscibility temperature
3. Construction of phase diagrams of three component systems with one pair of partially miscible liquids

2. Distribution law

1. Distribution coefficient of iodine between an organic solvent and water
2. Distribution coefficient of benzoic acid between benzene and water

3. Surface tension - Determination of surface tension of a liquid by

1. Capillary rise method
2. Drop number method

4. Polarimetry

1. Kinetics of the inversion of sucrose in the presence of HCl
2. Determination of the concentration of a sugar solution
3. Determination of the concentration of Hcl

5. Refractometry

1. Identification of pure organic liquids and oils
2. Determination of molar refractions of pure liquids
3. Determination of concentration of solutions (KCl- water, Glycero -water)

6. Viscocity

1. Determination of viscosity of pure liquids
2. Verification of Kendall's equation
3. Determination of composition of binary liquid mixtures – alcohol-water, benzene – nitrobenzene

References

1. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J.W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edn., McGraw Hill, 2009.

SEMESTER III

MCH 2301: Solution Chemistry, Kinetics and Photochemistry

Credits: 3

Module I Ideal solution and Colligative properties

Kinds of solutions, ideal solution, Analytical form of chemical potential in ideal solution,Chemical potential of the solute in a binary ideal solution, Application of the Gibbs-Duhem equation, the chemical potential in ideal solutions, binary solutions The lever rule, Temperature – composition diagram, Fractional distillation, Azeotropes, The chemical potential in ideal dilute solutions, Henry's law and the solubility of gases, Chemical equilibrium in the ideal solutions

Module II Equilibria in Non-ideal Systems

The concept of activity, The rational system of activities, Activities and reaction equilibrium,Activities in electrolytic solutions, The Debye-Huckel theory of the structure of dilute ionic solutions, Equilibria in ionic solutions, dilution law, Dissociation constant, Acids and bases, Protolytic equilibrium, , Hydrolysis, Dissociation constant for polybasic acids, Buffer solutions, Amphoteric electrolytes. Solubility product.

Module III Kinetics

Solution Kinetics - Potential energy surfaces - transition state theory- activation/ thermodynamicparameters.Various theories of Unimolecular reactions, Elementary Reactions in Solutions: Influence of solvent properties on rate. Different types of molecular interactions in solution. Diffusion and activation controlled reactions. Kinetics in the excited state - Jablonski diagram.Kinetics of Unimolecular and bimolecular photophysical and photochemical processes. Resonance energy transfer rates-Fluorescence quenching kinetics in solution and gas phase. Fast reaction kinetics -Relaxation methods, Stopped flow method, Laser Flash Photolysis, flow tube methods, and Laser based experimental techniques.

Module IV Photochemistry

Quantum yield, chemical ctinometry, excimers and exciplexes, photosensitization, chemiluminescence, bioluminescence, thermoluminescence, Principle of utilization of solar energy, solar cell and their working. Quenching of fluoresecence and its kinetics, Stern- Volmer equation, concentration quenching, fluorescence and structure, delayed fluorescence, E- type and P-type, Effect of temperature on emissions.

References

1. P.W. Atkins and J de Paula. Physical Chemistry, 9thedn., Oxford University Press, 2010
2. S. Glasstone. Introduction to Electrochemistry, Nabu Press, 2014.
3. G.W. Castellan. Physical Chemistry, 3rdedn., Addison Wesley, 1983
4. F. Daniels and R.A. Alberty. Physical Chemistry, 6thedn., John Wiley, 1984
5. A.A. Frost and R.G. Pearson. Kinetics and Mechanisms, John Wiley, 1961
6. K.J.H. Laidler. Chemical Kinetics, Tata McGraw Hill, 1993
7. S. Glasstone. Textbook of Physical Chemistry, Macmillan India Ltd., 1995

MCH 2302: Marine Natural Products

Credits: 3

Module I Drugs and pharmaceuticals from Marine Sources

Introduction, Marine secondary metabolites and their function, Some major marine drugs – anticancer agents, antimicrobial and antiviral compounds, analgesics (examples only), Marine organisms having potential bioactive compounds – Corals, marine micro organisms, marine plants, marine toxins as drugs, Fish and shell fish. Marine drugdevelopmet – problems and challenges.

Module II Seafood proteins

Nutritional value of seafood proteins, bioactive peptides, Isolation of seafood peptides-Functional value – Calcium binding, antibacterial and anti-oxidant activity. Marine enzymes – Isolation and applications, Anti-freeze proteins – applications, Cold adapted enzymes – applications.

Module III Seaweeds -Nutritional value, bioactive properties and uses

Proximate composition, seaweeds as dietary supplements, Seaweeds as sources of bioactive compounds – antioxidant, anti-bacterial and anti-viral activities, Industrial applications ofseaweeds – agriculture, aqua culture feed, anti-fouling agents, biosorption of heavy metals. Seaweed hydrocolloids – Agar, alginate, carrageenan – structure, extraction, properties and biological activity.

Module IV Marine Macromolecules as Nutraceutical Carriers and Biofilm

Matrix design for delivery of nutraceuticals, Marine macromolecules as delivery system,Biodegradable and edible films, Marine macro molecules as food coatings and edible films – marine proteins and marine polysaccharides, Nanotechnology for marine polysaccharide films and particles, Marine macromolecules as hydrogels and membrane for drug delivery, marine polysaccharides as Scaffolds.

Module V Isolation Techniques

Introduction, different extraction methods, purification by solvent extraction, chromatographictechniques (size exclusion, ion exchange, counter current), Idea about different spectroscopic techniques (already discussed in core paper).

References

1 Chemistry of marine natural products. Paul J Scheuer, 1973. Academic Press.
2. Handbook of Marine natural products. Fatturosso, Emesto, Gerwick, William H, TaglialatelaScafati, Orazio (Eds.) 2012. Springer.
3. Bioactive marine natural products. Bhakuni, Dewari S and Rawat P.S . 2005.
4. Handbook of Marine Biotechnology, S K Kim, 2015. Springer.
5. Marine products for health care. Functional and Bioactive nutraceutical compounds from the ocean. Vazhiyil Venugopal. CRC Press. 2009.

MCH 2303: Instrumental Methods in Marine Chemistry

Credits: 3

Module I Spectrophotometry

Fundamental laws of photometry, interference and photometric error, instrumentation ofphotometers**.** Flame Spectrophotometry – Flame emission spectrometry, Atomic absorption

Spectrophotometry – general principles and instrumentation, interferences, Cold vapour techniques for estimation of Mercury, metal hydride generation techniques, electro thermal atomisation. Atomic fluorescence spectrometry, Inductively coupled Plasma analysis**.**Basic instrumentation for UV-Vis, IR and Fluorescence spectrophotometers.

Module II Chromatographic Techniques
Classification of chromatographic techniques. Experimental techniques and applications of Ionexchange, Column, Thin Layer and Paper chromatography. HPLC and Gas Chromatography –Principle, Instrumentation and Detectors. Methods and applications.

Module III NMR and Mass Spectrometry
NMR – Basic Principles and Instrumentation of Continuous Wave and Pulsed Fourier TransformNMR Spectrophotometers, 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. J.M. Mermet, M.Otto, R.Kellner , Analytical Chemistry, Wiley –VCH, 2004.
2. D.A. Skoog, D.M.West, F.J.Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8thEdn, Saunders College Pub, 2007.
3. G.D. Christian, J.E. O'Reilly, Instrumental Analysis, Allyn and Bacon, 1986.
4. J.H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub 1990.
5. J.G. Dick, Analytical Chemistry, R.E. Krieger Pub., 1978.

MCH 2304: Marine Pollution

Credits: 3

Module – I Marine Pollution
Definition, Categories of additions, Pollutant and its classification. Organic wastes: BOD,COD, dilution factor, Fluctuations in DO, Consequences of organic discharges to estuaries with examples; Sewage treatment: Primary, Secondary and Tertiary treatment processes. Solid waste pollution: Classification and disposal of solid wastes.

Module – II Marine Pollution II
Oil spills and cleanup: Sources, Major accidental spills, fate of spilled oil on the sea,consequences of oil spills and treatment of oil spills.
Pesticide pollution: inputs, fate in the sea, factors affecting the bioaccumulation of pesticides, DDT the most wide spread molecule, Impact of pesticides on the Environment, Mode of poisoning of pesticides, Methods to minimize pesticide pollution.
Conservative pollutants: Measures of contamination, toxicity, measurement of toxicity, acute and chronic exposure, Detoxification. Metal pollution in coastal waters (Hg, Pb, Cd, Cu, Zn and Fe).
Radioactive Pollution: Sources, Classification and effects of radiation; Protection and control from radiation: Maximum permissible dose concept, dose limits, Disposal of radioactive wastes; Beneficial aspects of radiation and food safety.

Module III Industrial Pollution
Sources, nature and their treatment processes with reference to wastes from paper and pulp and soap manufacturing industries.

Marine corrosion: Definition, corrosion reactions, classification of corrosion, factors affecting corrosion of metals in sea water and prevention of marine corrosion. The state of some seas

Module IV Arctic:
Major features and processes: cryosphere, atmosphere, biosphere, and hydrosphere. Arcticfjords –functioning and importance; Role of Arctic in climate change; response of Arctic to global warming and climate change. Arctic sea ice system – importance to the global oceanography and climate.

References:

1. Bettina Kaiser, Polar Science and Global Climate: An International Resource forEducation & Outreach. Pearson Bookshop, 2010.
2. Turner, J. & Marshall, G. J., Climate Change in the Polar Regions. Cambridge UniversityPress, 2011.
3. David W. H. Walton, Antarctic Science, Cambridge University Press, 1987.
4. Veronika Meduna, Science on Ice: Discovering the Secrets of Antarctica, AucklandUniversity Press, 2013.
5. Committee on Future Science Opportunities in Antarctica and the Southern Ocean, FutureScience Opportunities in Antarctica and the Southern Ocean, The National academy Press,2011.
6. Stephen Rintoul et al. (Editors), The Southern Ocean Observing System: Initial Science andImplementation Strategy. Scientific Committee on Antarctic Research, 2011
7. Mark Serreze and Roger Barry, The Arctic Climate System, Cambridge University Press,2009.
8. Climate Change and Arctic Sustainable Development - Scientific, social, cultural and educational challenges. UNESCO Publishing, 2009.

MCH 2309: Coastal Zone Management

Credits: 3

Module I Coastal Zone:
Coastal zone, Coastal zone regulations, Beach profile, Surf zone, Off shore, Coastal waters, Estuaries, Wet lands and Lagoons, Living resources, Non-living resources.

Modules II Wave Dynamics:
Wave classification , Airy's Linear Wave theory, Deep water waves , Shallow water waves, Wave pressure, Wave energy, Wave Decay, Reflection, Refraction and Diffraction of waves, Breaking of waves, Wave force on structures, Vertical, Sloping and stepped barriers Force on piles.

Module III Coastal Processes:
Erosion and depositional shore features, Methods of protection, Littoral currents, Coastal aquifer, Sea water intrusion, Impact of sewage disposal in seas.

Module IV Harbours:
Structures near coast, Selection of site, Types and selection of break waters, Need and mode of dredging, Selection of dredgers, Effect of Mangrove forest.

References

1. Richard Sylvester, "Coastal Engineering, Volume I and II", Elseiner Scientific Publishing Co.,1999.
2. Quinn, A.D., "Design & Construction of Ports and Marine Structures", McGraw-Hill Book Co.,1999.
3. Ed. A.T. Ippen, "Coastline Hydrodynamics", McGraw-Hill Inc., New York, 1993.

4 .Dwivedi, S.N., Natarajan, R and Ramachandran, S., "Coastal Zone Management in Tamilnadu".

MCH 2310: Science Writing and IPR

Credits: 3

Module I Science Writing :
Introduction to science writing – goals, key elements – critical aspects – precision, clarity, objectivity.Genre in science writing -- articles, reviews, memoirs, project reports, proposals, popular science.Communication of research results, foundations and structure of a good scientific paper.English language considerations in writing a paper.Ethical issues - plagiarism. Presentation of data, figures, tables, references. Presentation of papers at conferences and preparation of audio--visual tools.

Module II Science Journalism:
Science communication and science popularization. Science popularization in the Indian context; Basics of popular science writing for magazines and newspapers; Research communication versus popular communication; Science communication through R&D newsletters, reports, etc.; Creation of information resources, e.g. encyclopaedic publications, etc; Use of modern IT tools in science communication; Role of graphic arts in popular science communication; Production of S&T publications

Module III IPR:
IPR, overview of IPR, Types of IPR, Indian laws and procedures. IP as source of information and access to information, Classification and tools for accessing the information, IPR in Engineering, pharmaceutical, biotechnological and computer related inventions, Prosecution, Infringement and Enforcement of IPR.

Module IV Patents:
Overview of Patent Act, legislations, International / global patent. Content of regular patent application, Claims of patent application, Specific types claims, Patent claim design, patent specification drafting in pharmaceutical, biotechnological engineering and computer science related inventions, Drafting issues in prosecution and infringement.

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. R.L. Dominoswki, Research Methods, Prentice Hall, 1981.
4. J.W. Best, J.V. Kahn, Research in Education, 10th Edn., Pearson/Allyn&Bacon, 2006.
5. H.F. Ebel, C. Bliefert, W.E. Russey, The Art of Scientific Writing, Wiley-VCH, 2004

MCH 2305: Physico-Chemical Methods (Practical)

Credits: 2

1. Phase Diagram
   I. Simple eutectic
   II. Compound formation
   III. Miscible liquids

IV. Partially miscible liquids

2. Critical solution temperature and effect of electrolytes and non-electolytes
2. 1. Three component system

3. Distribution coefficients
3. 1. Partition coefficient

4. I-I3 equilibrium
5. Kinetics – Acid – base catalysed hydrolysis of esters, dependence of temperature and ionic strength on the rate of reactions

6. Adsorption
6. 1. To investigate the adsorption of oxalic acid from aqueous solution by activated charcoal, and examine the validity of Freundlich and Langmuir's adsorption isotherms.
6. 2. To determine the adsorption isotherms of acetic acid from aqueous solutions by charcoal.

References

1. Findlay Alexander. Practical Physical Chemistry, 6th edn., Longman and Co., London, Newyork, 1935.
2. D.P. Shomaker and C.W. Gailand, J.W. Nibler. Experiments in Physical Chemistry, 6th edn., 1997.
3. J.B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 200.
4. B. Viswanathan, Practical Physical chemistry, Viva Pub., 2005.
5. G.W. Garland, J.W.Nibler, D.P.Shoemaker, Experiments in Physical Chemistry, 8th Edn., McGraw Hill, 2009.

MCH2306: Instrumental techniques in aquatic analysis (Practical)

Credits: 2

1. Analysis of trace metals in water/sediment/biological samples.
2. Flame photometry – Determination of sodium, potassium, calcium and lithium.
3. Atomic Absorption Spectrophotometry
a. Flame methods – Trace analysis of copper, cadmium, zinc, lead, manganese, iron b. Hydride generation – Determination of mercury, arsenic, selenium, tin
4. ICP – Analysis of trace metals in water.
5. Gas chromatography (GC) and HPLC – Separation and identification of marine organic compounds.
6. Interpretation Exercises using spectra:
   a) Interpretation of FTIR spectrum with reference to stretching vibrations of functional groups.
   b) Absorption spectra (UV-VIS) reading and interpretation of chromophores
   c) Interpretation of NMR spectrum with reference to calculation of chemical shifts and general comments
   d) Identification of molecular ions in Mass spectra

References

1. D.T.E. Hunt and A.L. Wilson. The Chemical Analysis of Water, 2nd edn., Royal Society of

Chemistry, 1986
2. Instrumental Manuals of AAS, Fluorescence Spectrophotometer, GC and CHN Analyzer.
3. R.M. Silverstein and F.X. Webster, Spectrometric Identification of Organic Compounds, 6th edn., Wiley, 2006.
4. R. Dyer John. Applications of Absorption Spectroscopy of Organic Compounds, Prentice-Hall, 1978.
5. E. Pretsch, P. Bhlmann and M. Badertscher. Structure Determination of OrganicCompounds, Springer-Verlag, 4th edn., 2009.
6. D.A. Skoog, D.M.West, F.J.Holler and S.R. Crouch. Fundamentals of AnalyticalChemistry, 9th edn., Cengage Learning, 2013.
7. IOC Manuals and Guides-11. The determination of Petroleum Hydrocarbons in Sediments, UNESCO, 1982. R.M Silverstein, Spectrometric identification of Organic compounds
8. IOC Manuals and Guides-13.Manual for monitoring Oil and Dissolved/DispersedPetroleum Hydrocarbons in Marine Waters and on Beaches UNESCO, 1984
9. Aquatic Environment Analytical Methods. Methods of Analysis of Hydrocarbons inMarine and Protection: Other Samples, MAFF, 1988
10. Aquatic Environment Analytical Methods. Methods of Analysis of Trace Metals inMarine and Protection: Other Samples, MAFF, 1989
11. J.Bassett, R.C. Denney, G.H.Jeffery and J.Mendham. Vogel's Text Book of Quantitative Inorganic Analysis 4th edn., ELBS, 1982.