GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

REVISED MINUTES

of the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

Saturday, 30th July, 2022

Time

10.00 a.m.

Council Hall
Goa University

	2. The Course Codes for the PG programmes to be revised/changed. The Controller of Examination was requested to draw up a uniform pattern to be made applicable across all disciplines in consultation with a few Deans and the Chairpersons of the Boards of Studies. 3. The Chairperson, Board of Studies was requested to rework on the following Elective Courses giving more details: a) MMO-22-213 'Field Trip/Study Tour – Practical' b) MMO-22-214 'Internship' **(Action: Assistant Registrar Academic – PG)**
D 3.2	**Minutes of the Board of Studies in Marine Science meeting held on 28.04.2022.** The Academic Council approved the minutes of the Board of Studies in Marine Science meeting held on 28.04.2022 with the following suggestions: 1. The month and year mentioned in the heading of the Syllabus document to be corrected from September 2022 to August 2022. 2. The Course Codes for the PG programmes to be revised/changed. 3. Total Number of Credits indicated as a footnote to the Programme Structure to be deleted. **(Action: Assistant Registrar Academic – PG)**
D 3.3	**Minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022.** The Academic Council approved the minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022 with the following suggestions: 1. The number of hours to be assigned to each module in Courses. 2. Theory component of one credit to be included for the Practical Courses. 3. Course GLC-22-107 Geological Field Mapping to be offered as a new Theory Course. 4. Course Code: GLC-22-207 Geological Field Training to be included as a part of the Dissertation. **(Action: Assistant Registrar Academic – PG)**
D 3.4	**Minutes of the Board of Studies in Mathematics meeting held on 22.04.2022.** The Academic Council approved the minutes of the Board of Studies in Mathematics meeting held on 22.04.2022 with the following suggestions: 1. The Course Codes for the PG programmes to be revised/changed. 2. The word 'Optional Courses' to be replaced with 'Elective Courses'. 3. The Chairperson, Board of Studies was requested to resubmit the syllabus incorporating the suggestions. The Vice-Chancellor was authorized to approve the same on behalf of the Academic Council. The proposed syllabus for Semester III and Semester IV was deferred. **(Action: Assistant Registrar Academic – PG)**

X AC- 9 (Special)
30.07.2022

GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

F I N A L U P D A T E D A G E N D A

For the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

30th July, 2022

Time

10.00 a.m.

Venue
Conference Hall
Administration Block

Part D

i. Recommendations regarding general academic requirements in the Departments of University or affiliated colleges: **Nil**

ii. Recommendations of the Academic Audit Committee and status thereof: **Nil**

Part E.

i. Recommendations of the text books for the course of study at undergraduate level: **Nil**

ii. Recommendations of the text books for the course of study at post graduate level: **Nil**

Part F.

Important points for consideration/approval of Academic Council

i. The important points/recommendations of BoS that require consideration/approval of Academic Council (points to be highlighted) as mentioned below

(a) The program structure and syllabus in Marine Microbiology (Semester I and II) was deliberated and few suggestions made by the Experts were incorporated and the same was approved. (Annexure I refer page no.1).

(b) The syllabus for the Ph. D. Entrance test for Marine Microbiology was placed and approved by the Academic Council in its meeting held on 13.05.2022.

(c) Approval of syllabus for Research Methodology paper - This item was deferred.

ii. The declaration by the Chairperson that the minutes were readout by the Chairperson at the meeting itself.

Date: 19.04.2022
Place: Goa University

Sd/-
Signature of the Chairperson

Part G. The Remarks of the Dean of the Faculty

i. The minutes are in order

ii. The minutes may be placed before the Academic Council with remarks if any.

iii. May be recommended for approval of Academic Council.

(i) Special remarks if any.

Date: 19.04.2022
Place: Goa University

Sd/-
Signature of the Dean

(Back to Index)

D 3.2 **Minutes of the Board of Studies in Marine Science meeting held on 28.04.2022.**

Part A

i) Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level.

ii) Recommendations regarding courses of study in the subject or group of subjects at the post- graduate and under –graduate level.

1. **BOS members met on 28.04.2022 at 1430 hrs. in the school of SEOAS for Marine Sciences and deliberated on Syllabus of restructured 80 credits M.Sc. program for Semester I and II. Annexure I (refer page no. 43)**

	2. **Members of the BOS deliberated on the above matter and approved the syllabus with some minor corrections.** **Part B** i) Scheme of examinations at the under-graduate level.NIL ii) Panel of examiners for different examinations at the under – graduate level.NIL iii) Scheme of examinations at the post-graduate level. NIL iv) Panels of Examiners for different examinations at post-graduate level.NIL **Part C** i) Recommendations regarding preparation and publication of selection of reading material in any subject or group of subject or group of subjects and names of persons recommended for appointment to make the selection. **Part D** i) Recommendations regarding general academic requirements in the Department of University or affiliated Colleges. NIL **Part E** i) Recommendations of text books for the courses of study at the under-graduate Level.NIL ii) Recommendations of text books for the courses of study at Post-graduate level NIL **Part F** i) The declaration by the Chairman, that the minutes were read out by the Chairman at the meeting itself. **The Chairman read out the minutes of the meeting to all the members.** Sd/- Date: 28.04.2022 Signature of the Chairman Place: Goa University **Part G:** The remark of the Dean of Faculty 1) The minutes are in order. 2) The minutes may be placed before the Academic Council with remark, if any. 3) Approved syllabus at BOS held on 20.04.2018. Sd/- Date: 28/04/2022 Signature of the Dean Place: Goa University Dean SEOAS **(Back to Index)**
D 3.3	**Minutes of the Board of Studies in Earth Science (Applied Geology) meeting held on 29.04.2022.** **Part A**. i. Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level:----- Nil ii. Recommendations regarding courses of study in the subject or group of subjects at the postgraduate level:

D 3.2 Minutes of the Board of Studies in Marine Science meeting held on 28.04.2022.

Annexure I

Goa University
P.O. Goa University– 403 206, Taleigao Plateau, Goa, India
Syllabus of M.Sc. (Marine Sciences) Program
Effective from: September, 2022

Brief description of the course

Purpose: Mentoring trained manpower in different branches of Marine Sciences.

Prerequisites: Degree of Bachelor of Science of this University or an examination of any other University recognized as equivalent thereto, with at least seven units of 100 marks in the first, second and third years taken together. Eligibility is science graduate namely Maths, Physics, Chemistry, Biology, Hydrochemistry, Environmental Science, Environmental Chemistry, Marine Science, Ocean Science, Biotechnology, Earth Sciences, Geology and equivalence.

Credits (theory, practical): 01 credit (theory) shall be equivalent to 15 clock hours of contact teaching. 15 clock hours are inclusive of lectures/group discussion/seminars/problem solving/tutorials/assessment, 01 credit (practical) shall be equivalent to 30 clock hours (15 practical of 02 clock hours duration each) of contact teaching. The assessment of the courses shall be fully internal and the evaluation of the courses shall be by continuous assessment. The weightage of marks for intra and semester-end examinations in both theory and practical courses shall be 40:60. Each Internal Semester Assessment (ISA) shall be evaluated for 20% of the total marks of the course. Total number of ISA for each course shall be two irrespective of the number of credits. An additional assessment irrespective of number of credits of course carries, will be provided on the request of students to improve the grade, in which case the assessment with the least score shall not be considered for ISA. For 01 credit course, a single ISA shall be conducted and evaluated for 40% of total marks of the course. The duration of all comprehensive written Semester End Assessment (SEA) examinations carrying 25 marks or less, shall be of one hour; SEA carrying above 25 marks up to 50 marks shall be two hours; SEA carrying above 50 marks shall be of three hours.

Distribution of the courses: The students will be eligible for the Master's degree on the successful completion of courses equivalent to 80 credits. Student shall not be allowed to register for less than 10 credits and more than 25 credits in a semester. A student must obtain 32 core credits from the parent Department. Among the remaining 32 optional credits, 08 credits are discipline specific, 12 credits are research specific, 12 credits are generic which may be earned by the student by opting for courses (optional) either from the parent Department or from any other Department of the University.

Dissertation: Dissertation (16 credits) is compulsory. Topics will be assigned at the end of 3rd Semester. There will be a continuous internal monitoring by the guiding/supervising teacher.

Field Studies: M.Sc. Marine Sciences involves regular onboard training on research vessel/ boat.

M.Sc. Marine Sciences Program Structure and Syllabus (with effect from September, 2022)

Semester I

Course Code	Course Title	L–T–P(hours /week)	Credit(s)	Page Number
MSC–22–101	Physical Oceanography	3–0–0	3	5
MSC–22–102	Physical Oceanography Practical	0–0–2	1	8
MSC–22–103	Marine Chemistry	3–0–0	3	10
MSC–22–104	Marine Chemistry Practical	0–0–2	1	13
MSC–22–105	Marine Biology	3–0–0	3	15
MSC–22–106	Marine Biology Practical	0–0–2	1	18
MSC–22–107	Marine Geology	3–0–0	3	21
MSC–22–108	Marine Geology Practical	0–0–2	1	24
MSO–22–109	Ocean-Atmosphere Coupling and Climate	3–0–0	3	26
MSO–22–110	Ocean-Atmosphere Coupling and ClimatePractical	0–0–2	1	29
MSO–22–111	Marine Geochemistry	3–0–0	3	32
MSO–22–112	Marine GeochemistryPractical	0–0–2	1	34
MSO–22–113	Marine Ecology	3–0–0	3	36
MSO–22–114	Marine EcologyPractical	0–0–2	1	39

Total Number of Credits: 20**; Core:**16**, Optional:** 04**; Theory:** 15**,Practical:** 05

Semester II

Total Number of Credits:20**;Core:**16**, Optional:** 04**; Theory:** 15**,Practical:** 05

(Back to Index) (Back to Agenda)

SEMESTER I

Course Code: MSC–22–101
Title of the Course: Physical Oceanography
Number of Credits: 03

Prerequisites for the course:	A degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To provide a basic understanding of physical oceanographic variables and processes	
Content:	**Module I** Oceanographic explorations – Evolution of theoretical ideas – Units used in oceanography – The role of observations in oceanography – Ocean and seas – Dimensions of the ocean – Physical properties of water – Influence of dissolved salts – Physical properties of sea-water – Salinity – Temperature – Density – Distribution of temperature, salinity and density in low, mid and high latitudes and their seasonal variations – Oceanic mixed layer and thermo-cline – Instruments used for the measurement of temperature and salinity – Sound in the sea – Propagation of sound in the sea – Light in the sea – The oceanic heat budget – Shortwave radiation, longwave radiation – Sensible and latent heat fluxes and net heat flux – Bowen's ratio – T.S.V. diagram – T.S. diagram. **Module II** The earth in space – Composition of atmosphere – Vertical extent of atmosphere – Measurement of wind – Calculations of wind stress – Coriolis force – General circulation of atmosphere – Atmospheric temperature – Temperature systems and scales – Atmospheric humidity – Vapour pressure – Ocean Circulation: Wind-driven and thermo-haline circulations – Sea ice. **Module III** Equatorial processes – El niño and Southern Oscillationand their tele-connections – Indian Ocean Dipole (IOD) – Indian Ocean Circulation – Oceanic fronts – Upwelling: open ocean and coastal upwelling – Water masses in the ocean: Bottom water, Deep water, Antarctic intermediate water, Central water, Arabian Sea, Persian Gulf, Red Sea water masses and Bay of Bengal water – Lagrangian and Eulerian methods for measuring currents.	15hours 15hours 15 hours
Pedagogy:	Lectures/ tutorials/ assignments	

References/Readings:	1. Colling, A. (2001). *Ocean circulation (Second Edition) (Vol. 3)*. Butterworth-Heinemann in association with The Open University. 2. Wright, J., & Colling, A. (1995). *Seawater: its composition, properties, and behavior (Second Edition)*. Pergamon Press, in association with the Open University. 3. Talley, L. D.,Pickard, G. B., Emery, W. J., & Swift, J. H. (2011). *Descriptive physical oceanography: an introduction (Sixth Edition)*. Academic press. 4. Neumann, G. S., & Pierson Jr., W. J. (1966). Principles of physical oceanography.Englewood Cliffs, New Jersey, U.S.A.: Prentice-Hall 5. Ahrens, C. D. (1985). *Meteorology today: an introduction to weather, climate, and the environment (Second Edition)*. St. Paul, Minnesota, U.S.A.: West Publishing. 6. Wells, N. C. (2012). *The atmosphere and ocean: a physical introduction*.Chichester, West-Sussex, U.K.: Wiley-Blackwell. 7. Pal, A. S. (2001). *Introduction to micrometeorology (Second Edition)*. Academic Press. 8. Tomczak, M., & Godfrey, J. S. (2001). Regional Oceanography: an Introduction. Online edition. https://www.geo.uni-bremen.de/~apau/dynamicclimate/course_materials_2015/Resources/tomczak_godfrey_1994.pdf 9. Stewart, R. H. (2008). *Introduction to physical oceanography*. Robert H. Stewart. https://open.umn.edu/opentextbooks/textbooks/20	
Learning Outcome:	An understanding of basic physical oceanographic processes in different parts of the world ocean.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–102
Title of the Course: Physical Oceanography Practical
Number of Credits: 01

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To develop an ability to analyse physical oceanographic properties and decipher associated processes	
Content:	1. Analysis of vertical profiles of temperature, salinity and density to understand the physical processes at low, mid and high latitudes of the world ocean (6 hours; References 1 and 2) 2. Distinguish variation in properties of upwelling and non-upwelling periods/ regions using a) temperature, b) salinity and c) density (3 hours; References 1 and 2) 3. Vertical section of temperature to study the physical processes along a transect (6 hours; References 1, 2 and 3) 4. Vertical section of salinity to study the physical processes along a transect (6 hours; References 1, 2 and 3) 5. Vertical section of density to study the physical processes along a transect (6 hours; References 1, 2 and 3) 6. Estimation and analysis of heat content in different parts of World Ocean (3 hours; References 4 and 5)	30 hours
Pedagogy:	Tutorials/ assignments/ practical/ field study	
References/Readings:	1. Wright, J., & Colling, A. (1995). *Seawater: its composition, properties, and behavior (Second Edition)*. Pergamon Press, in association with the Open University. 2. Stewart, R. H. (2008). *Introduction to physical oceanography*. Robert H. Stewart. https://open.umn.edu/opentextbooks/textbooks/20 3. Colling, A. (2001). *Ocean circulation* (Second Edition) (Vol. 3). Butterworth-Heinemann in association with The Open University. 4. Tomczak, M., & Godfrey, J. S. (2001). Regional Oceanography: an Introduction. Online edition. https://www.geo.uni-bremen.de/~apau/dynamicclimate/course_materials_2015/Resources/tomczak_godfrey_1994.pdf 5. Fofonoff, N. P., & Millard Jr., R. C. (1983). Algorithms for the computation of fundamental properties of seawater. UNESCO Technical Papers in Marine Science 44, Endorsed by UNESCO/SCOR/ICES/IAPSO/ Joint Panel on Oceanographic Tables and Standards and SCOR Working Group 51; Place de Fontenoy, Paris, France: UNESCO. D.o.i.: https://doi.org/10.25607/OBP-1450	

Learning Outcome:	An ability to explain processes based on variations of the conservative properties of ocean and describe spatial and temporal variation of ocean processes.	

Course Code:MSC–22–103
Title of the Course: Marine Chemistry
Number of Credits: 03

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To learn the basic concepts of the chemistry of the marine environment that concerns the study of the properties and interactions of the substances.	
Content:	**Module I** Symbols and units used in chemical oceanography – Major and minor elements in seawater – Geochemical balance of the oceans – Goldschmidt material balance – cycle of cationic and anionic species in the lithosphere, atmosphere, hydrosphere and biosphere systems, residence time of the elements in the ocean, chemical speciation in seawater – Dissolved species – Particulate species – Activity coefficient – Hydration of ion in seawater. **Module II** Constancy of relative ionic composition of seawater, conditions under which major elements may not be conservative, factors affecting the distribution of trace elements in the sea, interaction of trace elements with marine organisms, enrichment factor, vertical distribution of trace elements in the ocean, Chlorinity and salinity: definition and significance, practical salinity scale, Radioactive nuclides in the sea, Redox chemistry of seawater. **Module III** Dissolved gases (other than CO_2) in seawater – Basic concepts : effect of pressure, salinity, temperature on solubility of gases in seawater, air – sea gas exchange, processes affecting their distribution, dissolved oxygen in the ocean – Dissolved gases (CO_2) in seawater – Carbon dioxide equilibria in seawater; pH, Total, carbonate and Borate alkalinity, and buffering capacity of oceans: components of CO_2 system in seawater – Percentage composition of inorganic carbon; calcium carbonate precipitation and dissolution phenomena – Lyso-cline and carbonate compensation depth.	15 hours 15 hours 15 hours
Pedagogy:	Lectures/ tutorials/ assignments/ self-study	
References/Readings:	1. Riley, J. P., Chester, R. (1971). Introduction to Marine Chemistry. Academic Press. 2. Riley, J. P., Skirrow, G. (1975). Chemical Oceanography. Academic Press. 3. Horne, R. A. (1969). Marine Chemistry. Wiley-Interscience. 4. Wright, J., Wright, J.,Colling, A. (2004). Seawater: Its composition, properties & behaviour. Oxford: Butterworth-Heinemann in association	

	with the Open University. 5. Martin, D. F. (1970). Marine Chemistry. NY: Marcel Dekker. 6. Millero, F. J., Sohn, M. L. (1992). Chemical Oceanography. CRC Press. 7. Burton, J. D., Brewer, P. G., Chesselet, R. (1986). Dynamic Processes in the Chemistry of the Upper Ocean. Plenum Press. 8. Holland, H. D. (1978). The chemistry of the Atmosphere and Oceans. Wiley. 9. Bengtsson, L. O., Hammer, C. U. (2001). Geosphere – Biosphere Interactions and Climate. Cambridge University Press. 10. Sengupta, R., Naqvi, S. W. A. (1984). Chemical Oceanography of the Indian Ocean, North of Equator. Deep Sea Research, 31A, 671-706. 11. Millero, F. J. (2005). Chemical Oceanography. CRC Press. 12. Liss, P. S., Duce, R. A. (1997). The Sea Surface and Global Change. Cambridge University Press. 13. Fasham, M., Fasham, M. J. R. (2003). Ocean Biogeochemistry: The role of the ocean carbon cycle in Global change. Springer. 14. Turekian, K. K. (2010). Marine Chemistry and Geochemistry. Academic Press.	
Learning Outcomes:	1. A comprehensive understanding of the properties and interactions of the chemical substances present in the marine environment. 2. To understand the key chemical processes regulating the marine environment. 3. To understand the distribution of dissolved O_2 and the biogeochemical cycling of the metals in the marine environment.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–104
Title of the Course: Marine Chemistry Practical
Number of Credits: 01

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	This course deals with the analytical chemistry of the Seawater.	
Content:	6. Estimation of salinity of seawater by the Mohr- Knudsen chlorinity titration method (5 hours; Reference 1) 7. Estimation of salinity of seawater by Harvey's method (5 hours; References 1, 3, 4) 8. Determination of dissolved O_2 of seawater by Winkler's iodometric titration method (5 hours; Reference 1) 9. Determination of pH of seawater by potentiometric method using pH meter and determination of total alkalinity of seawater by potentiometric titration using pH meter (5 hours; Reference 1) 10. Estimation of carbonate and bicarbonate alkalinity by titrimetric method (5 hours; Reference 4) 11. Spectrophotometry: Verification of Beer's law (5 hours; Reference 2)	30 hours
Pedagogy:	Laboratory experiments/field studies	
References/Readings:	1. Grasshoff, K., Ehrhardt, M., Kremling, K. (1983). Methods of Seawater Analysis. VerlagChemie, Weinheim. 2. Ewing, G. W. (1981). Instrumental Methods of Chemical Analysis. NY: McGraw-Hill. 3. Parsons, T. R., Maita, Y.,Lalli, C. M. (1984). A Manual of Chemical and Biological Methods for Seawater Analysis. Oxford: Pergamon Press. 4. Martin, D. F. (1972). Marine Chemistry. NY: Marcel Dekker.	
Learning Outcomes:	1. To develop analytical skills to determine the concentrations of various chemical parameters. 2. The application of spectrophotometer for the analysis of colored solutions.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–105
Title of the Course: Marine Biology
Number of Credits: 03

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	Introduction of marine life, biological processes to elucidate the ecosystem function. Further, it also provides an insight on larval ecology, trophic levels and their role in supporting life in marine environment.	
Content:	**Module – I** Introduction to marine biology – oceanographic processes, history, classification, theories, expeditions, hypothesis testing; Origin of life – life processes, abio-genesis, theories of natural selection, organic evolution, primordial soup hypothesis, organic molecules, chemical evolution, iron sulfide and black smoker's theory, RNA world hypothesis, theory of evolution and panspermia, Theory of evolution. **Module – II** Basic ecological concepts and marine biotic structure, marine larval ecology, larval types and strategies, and bi-phased life cycle, Marine and coastal environment, biological zonation, inter-tidal ecosystem – rocky shore – zonation pattern – physical and biological factors, sandy shores and protected sand flats – physical and biological factors, faunal composition and adaptations. **Module – III** Sea as biological environment – physiological changes, regulators and conformers, scope for growth, temperature and metabolic rates, Production and distribution organic matter, microbial loop, re-mineralization. Primary productivity – mechanism, light and dark reaction, intermediate products, factor affecting primary productivity, role of pigments, methods of assessment, biological pump and transformation of organic matter, vertical profile of primary productivity and SCM, turbulence and MLD, Human impact and biological productivity.	15 hours 15 hours 15 hours
Pedagogy:	lectures/ tutorials/assignments/self-study	
References/Readings:	1. Peter Castro and Michael Huber, 2018, Marine Biology, 11th Edition, McGraw-Hill Publication, Ogden, USA. 2. Karleskint, George, Turner, Richard, Small, James, 2012, Introduction to Marine Biology , 4th Edition Cengage Learning, South-Western Macmillan, USA. 3. Carol Lalli, C.M. and Thimothy Parson, 1997, Biological Oceanography – An Introduction, (2nd edition) –, Elsevier Ltd. Amsterdam, Netherlands.	

	4. Nair, N.B. & Thampy, D.M , 1980, Textbook of Marine Ecology, ., Macmillan, London. 5. Herbert H. Thurman, Harold.V. Webber, 1991, Marine Biology, Harper Collins Publishers, New York City. 6. Lewis, J.R, 1965, The Ecology of Rocky Coasts, English Universities Press, London. 7. J. H. Price; D. E. G. Irvine; W. F. Farnham, 1980, The Shore Environment. Volume 1 & 2: Methods and Ecosystems, W.F. Systematics Association, Cambridge University Press, UK. 8. R. S. K. Barnes, Peter P. Calow, P. J. W. Olive, D. W. Golding, J. I. Spice . 1986, The Invertebrates (3rd Edn.),–, Wiley-Blackwell Science, New Jersey, USA. 9. James W. Nybakken and Mark D. Bertness, 2005, Marine Biology: An Ecological Approach, 6th Edition,–, Pearson/Benjamin Cummings, San Francisco.	
Learning Outcomes:	1. Provides fundamental knowledge related to marine life and processes. 2. To elucidate various strategies adopted by marine organisms for survival.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–106

Title of the Course: Marine Biology Practical

Number of Credits: 01

Prerequisites forthecourse:	DegreeofBachelorofScienceofthisUniversityoranexamination of any other university recognizedasequivalent.	
Objective:	To gain information on samplingdevices usedfor collection of marine organismsandidentificationofsome ofthemajorgroups.	
Content:	1. Introduction to standard sampling devices / instruments employed for collection and analysis ofbiologicalparameters inwaterandsediments usedinoceanographicstudies(4 hours; References 1, 2) 2. Design and execution of field / samplingsurveysforcollection of water and sediment samples (2 hours;Reference 2) 3. Analysis of biologicalcommunities (water and sediment), their preservation and storage techniques using standardmethods(4 hours;Reference 2) 4. Quantitative estimation& identification of phytoplankton in seawater (6hours;References 3, 4)	30hours

	5. Quantitative estimation of zooplankton using volume displacement, wet weight anddryweightmethod(3hours;Reference 5) 6. Qualitativeestimationofzooplanktonusingstereoscopicmicroscope(6hours; Reference 5) 7. Quantitative and qualitative estimation of benthic invertebrates (5 hours; References 6,7,8,9)	
Pedagogy:	Demonstrations/practical/designingofexperiments/identification techniques	
References/Readings:	1. Steele, J.H., Thorpe, S.A., &Turekian, K.K. (2010). *Marine Ecological Processes: A derivative of Encyclopaedia of Ocean Sciences*(2nded). Academic Press, San Diego, CA (USA). 2. Intergovernmental Oceanographic Commission (1994) *Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements*. Paris, France, UNESCO-IOC, 170pp. (Intergovernmental Oceanographic Commission Manuals and Guides: 29), (JGOFS Report; 19). DOI: https://doi.org/10.25607/OBP-1409. 3. Verlecar, X.N., Desai, S.R. (2004). Phytoplankton Identification Manual.National Institute of Oceanography, Dona Paula, Goa. 4. Goswami, S.C. 2004 Zooplankton methodology, collection and identification- a field manual. National Institute of Oceanography, Dona Paula, Goa. 5. Tagliapietra, D., Sigovini, M. (2010). Benthic fauna: collection and identification of macro-benthic invertebrates. In J. Dominik et al. (Eds.) *Terre et Environment*, *88*(pp. 253–261), Section des Science de la Terre, Université de Genève. 6. Barnes, R.D. (1980). *Invertebrates Zoology*(4th ed), Philadelphia: Saunders College. 7. Day, J.H. (1967). *A monograph on the Polychaeta of Southern Africa.*Natural History Museum (London) Publications. 8. Lyla, P.S., Velvizhi, S., Ajmal Khan, S. (1999). *A monograph on the amphipods of Parangipettai coast.*Annamalai University, India.	
LearningOutcomes:	Developabilitytoidentifymarine biota at specieslevel	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–107
Title of the Course: Marine Geology
Number of Credits: 03

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To introduces basic concepts of Marine Geologyto understand ocean basins, their dimensions, tectonics and evolution. Sediment components and processes with special reference to near-shore and beach dynamics; ocean mineral resources – application of fossils in paleoclimate and monsoon.	
Content:	**Module I** The earth and the solar system-origin and age of the earth – internal structure – Geological time scale – Size and shape of the ocean basins: Pacific, Atlantic and Indian – Morphology and structure of continental margins, mid oceanic ridges and deep sea floor – Origin of ocean basins – Continental drift, sea floor spreading and plate tectonics – Evolution of the Indian ocean. **Module II** Sediment, sediment grade scale and analysis – Classification, composition, distribution and source of sediments with emphasis on near shore areas – Surveying, sampling and laboratory techniques for the study of coastal and estuarine sediments – Analysis of sedimentological data and interpretation – Instruments used in marine geology. Beach and beach profile, variations in beach morphology and its significance – Near shore geological processes: erosion, transportation and deposition. **Module III** Sea bed minerals with emphasis on Indian ocean – Polymetallic nodules, phosphorites, carbonates, placer deposits and petroleum resources, gas hydrates – Fossilization process – Types of microfossils and classification, technique for paleoclimate reconstruction with respect to oxygen isotope studies, role of microfossils in paleo – oceanography, paleoclimate, marine archaeology, petroleum exploration and monitoring marine pollution& mitigation.	15 hours 15 hours 15 hours
Pedagogy:	Lectures / Assignments / Seminars / Discussion	
References/ Readings:	1. Boersma, A., &Haq, B. U. (Eds.). (1978). Introduction tomarine micropaleontology. Elsevier. 2. Cam, K. (1972). Beaches and coasts.Edward Arnold,London. 3. Dyer, K. R. (1986). Coastal and estuarine sedimentdynamics. Chichester: Wiley.	

	4. Gross, M. G. (1972). Oceanography: a view of the earth.Englewood Cliffs, N.J: Prentice-Hall. 5. Haq, B. U., &Milliman, J. D. (1985). Marine geology and oceanography of Arabian Sea and coastal Pakistan. 6. Haq, Bilal U. &Milliman, John D.(1984).Marine geology and oceanography ofArabian Sea and coastal Pakistan.New York :Van Nostrand Reinhold/Scientific and Academic Editions 7. Kennett, J. P. (1982). Marine geology. Prentice Hall INC Englewood, Cliffs, N. J. 07632 8. Komar, P. D. (1976). Beach processes and sedimentation. Englewood Cliffs, N.J: Prentice-Hall. 9. Petrushevskaya, M. G., Funnel, B. M., & Riedel, W. R. (1971). Micropaleontology of the Oceans. 10. Skinner, B. J. (1969). Earth resources. Englewood Cliffs,N.J.: Prentice-Hall. 11. Teleki, P. G., Dobson, M. R., Moore, J. R., & von Stackelberg, U. (Eds.). (2012). Marine minerals: advances in research and resource assessment (Vol. 194). Springer Science & Business Media. 12. Thurman, H. V., & Trujillo, A. P. (2004). Introductory oceanography. Upper Saddle River, N.J: Pearson Prentice Hall.
Learning Outcomes:	1. Understanding earth processes, evolution and mineral resources associated with ocean basins. 2. Ability to reconstruct paleoclimate and paleo-monsoon.

(Back to Index) (Back to Agenda)

Course Code:MSC–22–108
Title of the Course: Marine Geology Practical
Number of Credits: 01

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To introducetechniques tomeasure parameters to understand near-shore and beach dynamics, bathymetry and heavy minerals.	
Content:	1. Field survey (Beach) – locating a station using compass and GPS; Beach profile measurement and sediment sample collection from different parts of the beach (4hours; Reference 2) 2. Plotting station locations on the base map and beach profile; volume computation from the given data (2hours; Reference 2) 3. Conning and quartering, pre-treatment of sediment sample to remove calcium carbonate, organic matter and ferruginous material (2hours; References 1, 6) 4. Grain size analysis (sand) using Ro-tap sieve shaker – batch I (8hours; References 1, 6) 5. Computation of weight and cumulative percentages, plotting frequency and	30 hours

	probability graphs, computation of modes of transport and grain size parameters and interpretation (4hours; References 1, 6) 6. Heavy mineral separation from different fractions of sand and interpretation (4hours; Reference 1) 7. Plot bathymetry lines and interpret geomorphology (4hours; Reference 4) 8. Identification of microfossils under binocular microscope& its applications in paleoclimate. (2hours; Reference 6)	
Pedagogy:	Field surveys and sampling / Laboratory experiments / Computations / Plotting and interpretations	
References/Readings:	1. Friedman, G. M., & Johnson, K. G. (1982). Exercises in sedimentology. New York: Wiley. 2. Dionne, J.C. (1978). Komar, P.D. (1976). Beach Processes and Sedimentation, Englewood Cliffs (New Jersey), Prentice-Hall. 3. Krone, R. B., (1962). Flume studies of the transport of sediment in estuarial shoaling processes: Final report. Berkeley: Hydraulic Engineering Laboratory and Sanitary Engineering Research Laboratory, University of California. 4. Babu, S. K. &Sinha, D. K. (1987): Sedimentary Petrology Practical, CBS Pub., N. Delhi. 5. Mero, J. L. (1965). The mineral resources of the sea.Amsterdam: Elsevier Pub. Co. 6. Saraswati, P. K., &Srinivasan, M. S. (2015). Micropaleontology: Principles and applications. 7. Jones, E J. W. Marine Geophysics. Chichester: Wiley, 1999. Print.	
Learning Outcomes:	1. Conducting field survey and sampling 2. Conducting laboratory experiments 3. Ability to interpret data sets to understand processes	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–109
Title of the Course: Ocean-Atmosphere Coupling and Climate
Number of Credits: 03

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.

Objective:	To learn exchange of mass and energy across air-sea interface and its role in global climate.	
Content:	**Module I** Wind generation, forces acting on wind, wind stress, Methods of estimation of wind stress, drag coefficient – Geostrophic winds, cyclostrophic winds, thermal winds – Wind wave generation – Scales of interactions, General character of sea surface as a lower boundary of air flow – Geometry of the sea surface: Gravity waves, Wavelets and ripples, Sea-surface slopes, Slicks on the sea surface – Wind streaks, Periodic bands, Intermittent rippling, Non-periodic slicks – Instruments used in marine meteorology **Module II** The wind field in the maritime frictional layer in thermal indifferent conditions: Observational challenges, Theoretical considerations, Simplifying conditions, Hydrodynamic analogy – Austausch coefficient – Dynamic roughness –Measured wind profiles – General consideration of air-sea interaction – Planetary boundary layer – Laminar boundary layer, surface layer and Ekman layer **Module III** Determination of air-sea fluxes – Profile method and non-profile methods – Variation of air-sea fluxes with special reference to upwelling – Indian Summer Monsoons: causes, inter-annual and intra-seasonal variability, Monsoon trough, Low-Level Jet (LLJ), Tibetan Low, Mascarenhas High, tropical easterly jet (T.E.J.), Madden-Julian Oscillation (M.J.O.), Relationship of El niño, La niña and Indian Ocean Dipole (I.O.D.) in Indian Monsoon. Concepts in climatology – Radiation and its role on tropical circulation – Role of ocean heat fluxes in influencing climate change.	15hours 15hours 15hours
Pedagogy:	Lectures/ tutorials/ assignments	
References/Readings:	1. Nakamura, H., Isobe, A., Minobe, S., Mitsudera, H., Nonaka, M., & Suga, T. (2016). *Hot Spots in the Climate System: New Developments in the Extratropical Ocean-Atmosphere Interaction Research.* Springer Japan. D.o.i.: https://doi.org/10.1007/978-4-431-56053-1 2. Bortkovskii, R. S. (1987). *Air-Sea Exchange of Heat and Moisture During Storms.* Revised English edition by Edward C. Monahan. Springer Netherlands. 3. Roll, H. U. (1965). Physics of the marine atmosphere. *International Geophysics Series*, Vol. *7*. [Ed.] J. Van Miegham. London: Academic Press. 4. Asnani, G. C. (1993). *Tropical meteorology (Volume 1).* Pune, India: Asnani, Indian Inst. Of Tropical Meteorology. 5. Asnani, G. C. (1993). *Tropical meteorology (Volume 2).* Pune,	

	India: Asnani, Indian Inst. Of Tropical Meteorology. 6. Keshavamurthy, R. N., & Rao, M. S. (1992). *The physics of monsoons*. New Delhi, Bombay, Calcutta, Madras, Nagpur, Ahmedabad, Bangalore, Hyderabad, Lucknow: Allied Publishers Limited. 7. Pörtner, H.-O., Roberts, D. C., Tignor, M., Poloczanska, E. S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A., Rama, B. (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press. In Press. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/ 8. Wallace, J. M., & Hobbs, P. V. (2006). *Atmospheric science: an introductory survey (Second Edition)*. Academic Press. 9. Wells, N. C. (2012). *The atmosphere and ocean: a physical introduction*.Chichester, West-Sussex, U.K.: Wiley-Blackwell.	
Learning Outcome:	1. An insight about the exchange of momentum and ocean heat flux and their role in climate. 2. An understanding of the south-west monsoon and the formation and decay of tropical cyclones. 3. To understand the process of generation of winds, formation of waves and also growth and decay of El niño and La niña.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–110
Title of the Course: Ocean-Atmosphere Coupling and Climate Practical
Number of Credits: 01

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To analyse air-sea fluxes associated with different oceanic-atmospheric processes in the different parts of the world ocean.	
Content:	1. Data extraction from global data sets of shortwave radiation and analysis of its distribution/variation (6 hours; References 1, 2, 3, 4) 2. Data extraction from global data sets of long wave radiation and analysis of its distribution (6 hours; References 1, 2, 3, 4) 3. Data extraction from global data sets of sensible heat flux and analysis of its distribution (6 hours; References 1, 2, 3, 4) 4. Data extraction from global data sets of latent heat flux and analysis of its distribution (6 hours; References 1, 2, 3, 4) 5. Estimation of net heat flux from above extracted data sets and analysis of its distribution (6 hours; References 1, 2, 3, 4)	30hours
Pedagogy:	Tutorials/ assignments/ practical	
References/Readings:	1. Roll, H. U. (1965). Physics of the marine atmosphere. *International Geophysics Series*, Vol. *7*. [Ed.] J. Van Miegham. London: Academic Press. 2. Pörtner, H.-O., Roberts, D. C., Tignor, M., Poloczanska, E. S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A., Rama, B. (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press. In Press. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/ 3. da Silva, A. M., Young, C. C., & Levitus, S. (1994). *Atlas of surface marine data 1994, Vol. 1: Algorithms and procedures. NOAA Atlas NESDIS, 6.* Washington, D.C., U.S.A.: Department of Commerce. 4. Berry, D. I., & Kent, E. C. (2011). Air–sea fluxes from ICOADS: The construction of a new gridded dataset with uncertainty estimates. *International Journal of Climatology*, *31*(7), 987–1001. D.o.i.: 10.1002/joc.2059. https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.2059 5. Asnani, G. C. (1993). *Tropical meteorology (Volume 1).* Pune, India: Asnani, Indian Inst. Of Tropical Meteorology.	

	6. Asnani, G. C. (1993). *Tropical meteorology (Volume 2).* Pune, India: Asnani, Indian Inst. Of Tropical Meteorology. 7. Wells, N. C. (2012). *The atmosphere and ocean: a physical introduction*.Chichester, West-Sussex, U.K.: Wiley-Blackwell. 8. Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S. L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M. I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J. B. R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R., & Zhou, B. (2021). *IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press. https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/ 9. Shukla, P. R., Skea, J., Slade, R., Al Khourdajie, A., van Diemen, R., McCollum, D., Pathak, M., Some, S., Vyas, P., Fradera, R., Belkacemi, M., Hasija, A., Lisboa, G., Luz, S., & Malley, J. (2022). IPCC, 2022*: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, NY, USA: Cambridge University Press. Doi: 10.1017/9781009157926 . https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/ 10. Houghton, J. T., Meira Filho, L. G., Callander, B. A., Harris, N., Kattenberg, A., & Maskell, K. (1996). *Climate change 1995: The science of climate change: contribution of working group I to the second assessment report of the Intergovernmental Panel on Climate Change* (Vol. 2). Cambridge University Press. https://digitallibrary.un.org/record/223181?ln=en	
Learning Outcome:	1. An ability to explain spatio-temporal variability of fluxes and identify the possible governing factors.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–111
Title of the Course: Marine Geochemistry
Number of Credits: 03

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To introduce concepts of Marine Geochemistry to understand processes associated with energy and material transfer from land to sea.	
Content:	**Module I** Geochemical classification of elements – distribution and abundance of elements in lithosphere – Principle geochemical cycle, Chemical weathering. Suspended matter – Methods of collection and analysis, variation, composition of total suspended particulate matter in the ocean – settling rates of suspended matter – Physico-chemical factors in sedimentation – ionic potential, hydrogen ion concentration, redox potential and colloids – Behavior of major and trace elements during sedimentation – Geochemistry of deep-sea sediments – Application of major and minor elements in the reconstruction of marine paleo-environment. **Module II** Chemical and biological aspects of dissolved organic matter in the sea – Sources of supply and processes of removal of dissolved organic matter. Radioactivity – Classification – Primary, cosmogenic and artificial radio nuclides; distribution and occurrence of radionuclides, their properties in the marine environment and their decay series – Sampling and storage of radionuclides, radio chemical separation- Applications of radionuclides to the geochronology of marine sediments and rocks – Carbon dating methods in marine sediments, oceanic mixing and residence time. **Module III** The solid-solution interface – Electro-kinetic phenomena, The electrical double layer, the structure of water at the solid solution interface, surface chemistry of oxides, hydroxides and oxide minerals; the colloidal state, origin of surface charge, aggregation of colloids, the role of coagulation in natural waters – Surface phenomena – Langmuir and Freundlich Adsorption isotherms, trace metal partitioning on solid-solution phases, particle concentration effects.	15hours 15hours 15hours
Pedagogy:	Lectures / Assignments / Seminars / Discussion	

References/Readings:	1. Krauskopf, K. B. (1967). Introduction to Geochemistry. Mc.Graw-hill. 2. Goldschmidt, V. (1962). Geochemistry. Clarendon press.. 3. Mason, B., Moore, B. (1956). Principles of Geochemistry. John Wiley & Sons, Inc. 4. Riley, J. P., Skirrow, G. (1975). Chemical Oceanography. N.Y.: Academic Press. 5. Krauskopf, K. B., Bird, D. K. (1995). Introduction to Geochemistry. Mc-Graw Hill. 6. Drever, J. I. (1982). The Geochemistry of Natural Waters. Englewood Cliffs, NJ: Prentice-Hall, Inc. 7. Burton, J. D., Liss, P. S. (1976). Estuarine Chemistry. Academic Press. 8. Stumm, W., Morgan, J. J. (1996). Aquatic Chemistry. NY: Wiley Interscience. 9. Stumm, W. (1987). Aquatic Surface Chemistry. NY: Wiley Interscience. 10. Home, R. A. (1969). Marine Chemistry. NY: Reinhold Publishing Corporation.	
Learning Outcomes:	1. To understand geochemical processes involved in the transfer of material from land to sea.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–112
Title of the Course: Marine Geochemistry Practical
Number of Credits: 01

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	1. To determine quantitatively the composition of Earth and to discover laws which control the distribution of individual elements. 2. The chemical analysis of sediment to analyze the concentration of different constituents.	
Content:	1. Determination of organic carbon in sediment by titrimetric method.(6hours; References 1, 3) 2. Determination of phosphorus in sediment. (6hours; References 1, 2,3) 3. Digestion of sediment using HF:HNO_3:$HClO_4$ acid mixture. (8hours; References 3, 6) 4. Estimation of Cr in sediment (5hours; References 3, 4, 5, 6) 5. Estimation of Zn in sediment (5hours; References 3, 4, 5, 6)	30hours
Pedagogy:	Demonstrations/Laboratory experiments	
References/ Readings	1. Grasshoff, K., Ehrhardt, M., Kremling, K. (1983). Methods of Seawater Analysis. VerlagChemie, Weinheim. 2. Parsons, T. R., Maita, Y., Lalli, C. M. (1984). A Manual of Chemical and Biological Methods for Seawater Analysis. Oxford: Pergamon Press. 3. Loring, D. H., Rantala, R. T. (1992). Manual for Geochemical Analysis of Marine Sediments and Suspended Particulate Matter. Earth Science Reviews, 32, 235-283. 4. Riley, J. P., Skirrow, G. (1975). Chemical Oceanography. Academic Press. 5. Rice, E. W., Bridgewater, L. (2012). Standard Methods for the Examination of Water and Waste Water Analysis. Washington DC: American Public Health Association. 6. Jarvis, I., Jarvis, K. E. (1985). Rare-Earth Element Geochemistry of Standard Sediments: A Study Using Inductively Coupled Plasma Spectrometry. Chemical Geology, 53, 335-344.	
Learning Outcomes:	1. To develop an ability to analyze marine sediment constituents. 2. To understand the digestion of marine sediments to determine the concentration of metals in sediments.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–113
Title of the Course: Marine Ecology
Number of Credits: 03

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To understand the concepts related tomarine habitats and their role in ecosystem function.	
Content:	**Module – I** Marine ecosystems – pelagic and benthic, indiscriminate predation and area hypothesis, bio-turbation and turbidity currents, Deep sea biology – scheme of zonation, sampling, constraints, environmental factors, OMZ and food sources, adaptations, reproductive strategy, bioluminescence, night vision and mechanism of production, benthic community structure, diversity, hypothesis, Polar seas – physical and biological factors, sea ice communities, microbial food web, soft sediment communities, Hydrothermal vents and cold seep communities, deep sea sulfide metabolism, symbiotic associations, food web – vent communities, Marine food webs – role of pico and nano plankton, viruses and host specific interactions, nutrient dynamics, bacteria, heterotrophic flagellates,protozoans and their role in trophic transfer. **Module – II** Harmful Algal Blooms (HAB), major outbreaks, concern, oceanographic and ecological systems with HAB, effects and losses, HAB phenomena – oceanographic processes, population dynamics, adaptations, life history strategies, mixo-trophy and life cycle, behavioral and morphological adaptations, bio-toxin production, physical, chemical and biological interactions, impact of HAB, brevetoxins, causative species, bloom initiation, formation, propagation, decomposition, prevention –alterations in nutrient input, fresh water flow, circulation, restriction of introductions, and control – Chemical, biological, flocculants, role of zooplankton, viruses, parasites, bacteria. **Module – III** Fouling communities – biofilm, chemistry, EPS, quorum sensing, dispersal and adhesion mechanism in *Enteromorpha* and barnacle and fouling control, Introduces species – human caused global changes, invasions and extinctions, human health , and bio-invasion – anthropogenic input, range extensions, effect on life cycle and fish mortality, Benthic metabolism – benthic autotrophic	15hours 15hours 15hours

	processes, photochemical reactions, nutrient leaching, benthic production and vertical stratification, chemical composition of sediments, predators in sediment communities.	
Pedagogy:	Lectures / Assignments / Seminars / Discussion	
References/Readings:	1. *Michel J. Kaiser, Martin J. Attrill, Simon Jennings, and David Thomas (Editors), 2020, Marine Ecology – Processes, Systems, and Impact, (3rd Edition), Oxford University Press, UK.* 2. Frances Dipper, R V TAIT, 1998, Elements of Marine Ecology, (4th Edition), Elsevier, Amsterdam, Netherlands. 3. James W. Nybakken and Mark D. Bertness, 2005, Marine Biology: An Ecological Approach, 6th Edition, –, Pearson/Benjamin Cummings, San Francisco. 4. Levinton, J. S., 1982, marine EcologyPrentice-Hall, Inc., Englewood Cliffs, N.J., USA.. 5. T. R. Parsons, M. Takahashi and B. Habgrave, 1984, Biological Oceanographic Processes, 3rd edition, Pergamon Press, Oxford. 330 pp. 6. J. E. G. Raymont, 1980, Plankton & Productivity in the Oceans, Volume 1: Phytoplankton, 2nd Edition, Elsevier, Amsterdam, Netherlands. 7. J. E. G. Raymont, 1983, Plankton & Productivity in the Oceans, Volume 2: Zooplankton,, 2nd Edition, Pergamon press, Oxford. 8. Carol Lalli, C.M. and Thimothy Parson, 1997, Biological Oceanography –An Introduction, (2nd edition) –, Elsevier Ltd., Amsterdam, Netherlands. 9. Valiela Evans, 1995, Marine Ecological Processes, Springer Verlag, New York. 10. Mann, K.H., 2000, Ecology of coastal waters: with implications for management, 2nd edition, Blackwell Science, New Jersey, USA.	
Learning Outcomes:	1. To understand marine biological processes in different ecosystems. 2. To address marine ecological issues like HAB, sediment communities and processes related to these ecosystems.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–114
Title of the Course: Marine EcologyPractical
NumberofCredits:01

Prerequisitesfort hecourse:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To elucidate themethodsofestimatingwaterquality/environmentalparametersandthe use ofdifferenttechniques to address variousissuesinMarineEcology.	
Content:	1. Estimationofprimaryproductionbyusinglightand dark bottlemethod (6hours;Reference 1) 2. Estimationofchlorophylland phaeo-pigmentsinseawatersampleusingaspectro-photometricmethod(6hours;Reference 2) 3. Estimationof total organic carbon in seawater and/or sediment samples (6hours;References 3, 4). 4. Designing of an experimental set-up tostudy uptake of oxygen by fishin thelaboratory(6hours;Reference 5). 5. Computationofspeciesdiversity(H',JandD)indicesusingtheda taofphytoplankton/zooplankton analysis and their implications in ecologicalstudies(6hours;Reference 6).	30 hours
Pedagogy:	Laboratorytechniques,designingofexperiments,computationsan d data interpretation.	
References/Readi ngs:	1. Selvaraj, G.S.D. (2005). *Estimation of primary productivity (modified light and dark bottle oxygen method).* In G.J. Parayannilam (Ed.), *Mangrove ecosystems:A manual for the assessment of biodiversity* (pp. 199-200). CMFRI Special Publication No. 83, Kerala, India. 2. Aminot, A., Rey, F. (2001). Chlorophyll a: Determination by spectroscopic methods (pp. 17 pp). ICES Techniqnes in Marine Environmental Sciences. No. 30. 3. Dickson, A.G., Sabine, C.L., & Christian, J.R. (Eds.) (2007) *Guide to best practices for ocean CO_2 measurement.* Sidney, British Columbia, North Pacific Marine Science Organization, (pp. 191), (PICES Special Publication 3; IOCCP Report 8). DOI: https://doi.org/10.25607/OBP-1342 4. El Wakeel, S.K., Riley, J.P. (1957). Determination of organic carbon in the marine muds. *Journal Du ConseilIntrenational Pour L'exploration De La Mer*,*22*, 180–183. 5. Bolduc, M., Lamarre, S., Rioux, P. (2002).A simple and inexpensive apparatus for measuring fish metabolism. *Advances in Physiology Education26*(2), 129-132. 6. Begon,M.,Mortimer,M.&Thompson,D.J. (Eds.) (1996). *Population ecology: A unified study of plants and animals* (3rd ed). Wiley-Blackwell.	7.
LearningOutcome s:	1. To analyze water/sediment quality and estimate productivity using standard methods.	

	2. To develop an ability to formulate anddesign experiments to address specific issues related to marine ecology.	

(Back to Index) (Back to Agenda)

SEMESTER II

Course Code:MSC–22–201
Title of the Course: Estuarine and Coastal Physical Oceanography
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To impart knowledge about the hydro-dynamics of coastal waters to enable design activities related to environmental impact assessment. To highlight issues confronting the coastal areas due to both anthropogenic and natural processes.	
Content:	**Module I** Definition of estuaries – Physical characteristics of estuaries – Classification on the basis of fluid dynamics principles – Tides and tidal currents in estuaries – Tide-producing forces – tidal analysis and prediction – Salinity intrusion – Estuarine circulation and mixing – Stratification and entrainment – Fronts in estuaries – *Khazonn* lands – Processes in lakes – Anthropogenic impacts. Ekman transport– Upwelling and downwelling – Waves: Kelvin and Rossby waves, Edge waves, Seiches, Internal Waves, Tides, Surface Waves, Tsunamis – Longshore currents – Rip currents – Erosion – Deposition **Module II** Tropical cyclones: Cyclone structure, generation, growth and decay – Temperature, pressure field and wind speed and direction – Impact of cyclone landfall – Storm surges, wind and precipitation impact – Cyclones in north Indian Ocean.Global warming and sea level change and its impact – Mitigation measures. **Module III** Equipment used for physical oceanographic studies: Mechanical bathythermograph (MBT), Expendable bathythermograph (XBT), Reversing thermometers, CTD, Current meter, Acoustic Doppler Current Profiler (ADCP), sonic anemometer, Autosal, Moorings. Equipment used for atmospheric studies: psychrometer, anemometer, radio sonde, sun-photometer, radiation meter, Automatic Weather Station (A.W.S.). Research vessels: O.R.V. Sagar Kanya, F.O.R.V. Sagar Sampada, R.V. Sindhu Sadhana.	15hours 15hours 15 hours
Pedagogy:	Lectures/ tutorials/ assignments/ case-studies	

References/Readings:	1. Dronkers, J., & van Leussen, W. (1988). *Physical Processes in Estuaries.* Springer-Verlag. 2. Defant, A. (1960). Physical Oceanography (Volume 2). Oxford, U.K.: Pergamon Press. 3. Open University Course Team. (2000). *Waves, Tides and Shallow-Water Processes (Second Edition).*The Open University and Butterworth-Heinemann. 4. Gade, H. G., Edward, A., & Svendsen, H. (1982). *Coastal Oceanography.* New York, London: Plenum Press. 5. Dyer, K. R., (1997). *Estuaries: A Physical Introduction (Second Edition).* Chichester, New York: John Wiley. 6. Tomczak, M., & Godfrey, J. S. (2001). Regional Oceanography: an Introduction. Online edition. https://www.geo.uni-bremen.de/~apau/dynamicclimate/course_materials_2015/Resources/tomczak_godfrey_1994.pdf 7. Asnani, G. C. (2005). *Tropical Meteorology (Revised Edition).* Pune, India: G. C. Asnani, Indian Institute of Tropical Meteorology. 8. Kennish, M. J. (2001). *Practical Handbook of Marine Science (Third Edition).*CRC Press. 9. Pörtner, H.-O., Roberts, D. C., Tignor, M., Poloczanska, E. S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A., Rama, B. (2022). *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press. In Press. https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/ 10. Shukla, P. R., Skea, J., Slade, R., Al Khourdajie, A., van Diemen, R., McCollum, D., Pathak, M., Some, S., Vyas, P., Fradera, R., Belkacemi, M., Hasija, A., Lisboa, G., Luz, S., & Malley, J. (2022). IPCC, 2022*: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, NY, USA: Cambridge University Press. Doi: 10.1017/9781009157926 . https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/ 11. Sonak, S. M. (2014). *Khazan Ecosystems of Goa – Building on Indigenous Solutions to Cope with Global Environmental Change.* Dordrecht: Springer; d.o.i.: https://doi.org/10.1007/978-94-007-7202-1 12. de Sousa, S. N. *The Khaznam of Goa.* http://www.niobioinformatics.in/pdf/events/indianestuaries/dsouza.pdf	
Learning Outcome:	1. An ability to plan and execute studies related to coastal and estuarine ecosystem.	

	2. To create awareness about natural and anthropogenic pressures to coastal habitats. 3. Use of different equipments used for physical oceanographic and atmospheric studies.	

Course Code:MSC–22–202
Title of the Course: Estuarine and Coastal Physical Oceanography Practical
Number of Credits: 01

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To delineate and identify regions of water-masses, most-efficient sound-channel and estimate ocean currents and measure atmospheric parameters.	
Content:	1. Identification of water masses and determination of stability of water column using T-S diagram (6 hours; References 1–4) 2. Estimation of sound speed and determination of SOFAR channel in different parts of the world ocean (6 hours; References 1, 4) 3. Analysis of wind stress over world ocean (3 hours; References 1–4 and 6) 4. Computation and analysis of dynamic topography (6 hours; References 2, 3 and 5) 5. Measurements of atmospheric pressure, humidity, minimum and maximum temperature, computation of absolute humidity, specific humidity – Mixing ratio (3 hours; References 6 and 7) 6. Determination of cyclone intensity from satellite images using Dvorak technique (6 hours; References 8)	30hours
Pedagogy:	Tutorials/ assignments/ practical/ field study	
References/ Readings:	1. Wright, J., & Colling, A. (1995). *Seawater: its composition, properties, and behavior (Second Edition)*. Pergamon Press, in association with the Open University. 2. Colling, A. (2001). *Ocean circulation* (Second Edition) (Vol. 3). Butterworth-Heinemann in association with The Open University. 3. Pond, S., & Pickard, G. L. (1983). *Introductory Dynamical Oceanography (Second Edition).* Oxford, New York, Toronto, Sydney, Paris, Frankfurt: Pergamon Press. 4. Kennish, M. J. (2001). *Practical Handbook of Marine Science (Third Edition).*CRC Press. 5. Fofonoff, N. P., & Millard Jr., R. C. (1983). Algorithms for the computation of fundamental properties of seawater. UNESCO Technical Papers in Marine Science 44, Endorsed by UNESCO/SCOR/ICES/IAPSO/ Joint Panel on Oceanographic Tables and Standards and SCOR Working Group 51; Place de Fontenoy, Paris, France: UNESCO. D.o.i.: https://doi.org/10.25607/OBP-	

	1450 6. Ahrens, C. D. (1985). *Meteorology Today: An Introduction to Weather, Climate and the Environment (Second Edition).* St. Paul, Minnesota, U.S.A.: West Publishing. 7. Ackerman, S. A., & Knox, J. A. (2012). *Meteorology–Understanding the atmosphere (Third Edition).* Jones & Bartlett Learning 8. Velden, C., Harper, B., Wells, F. Beven, J. L., II, Zehr, R. Olander, T., Mayfield, M., Guard, C., Lander, M., Edson, R, Avila, L., Burton, A., Turk, M., Kikuchi, A., Christian, A. Caroff, P., & McCrone, P. (2006). The Dvorak Tropical Cyclone Intensity Estimation Technique: A Satellite-Based Method that Has Endured for over 30 Years. *Bulletin of the American Meteorological Society, 87(9),* 1195–1210. D.o.i.: https://doi.org/10.1175/BAMS-87-9-1195	
Learning Outcome:	1. An ability to identify water-masses. 2. To understand the variability of sound in sea and know its implications for underwater communication and detection of objects. 3. An ability to know ocean processes and circulation and to measure atmospheric parameters and strength of a cyclone.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–203
Title of the Course: Estuarine and Coastal Chemistry
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To understand the concepts about the chemistry of the estuarine environment related to the properties and interactions of the substances.	
Content:	**Module I** Estuary – a chemical perspective, Salinity distribution in estuaries, Classification based on geomorphology and tidal range, flushing time, mixing and diffusion dispersal of pollutants in estuaries and near shore areas – Conservative and non – conservative properties of dissolved constituents during estuarine mixing – Behaviour of dissolved oxygen and pH, Dissolved organic matter in estuaries – sources, sinks and general biogeochemistry. **Module II** Micro-nutrient elements (P, N and Si) in estuaries – Forms, distribution and cycle, N:P ratios – Stoichiometry of the uptake and regeneration of the nutrient elements and of oxygen, Biogeochemistry of P, N and Si in estuaries, Minor and trace metals in estuaries – metal ion species – behaviour.	15hours 15hours 15hours

	Module III Chemistry of surface microlayer – Origin, thickness and collection of surface material, properties of the surface microlayer, Chemistry of estuaries along east and west coast of India – water chemistry – surface sediment and core sediment chemistry – biochemistry, role of physico-chemical and biological factors in estuarine chemistry, Equipments and instruments used in chemical study.	
Pedagogy:	Lectures/tutorials/assignments/self-study.	
References/Readings:	1. Burton, J. D., Liss, P. S. (1976). Estuarine Chemistry. Academic Press. 2. Head, P. C. (1985). Practical Estuarine Chemistry. Cambridge University Press. 3. Olausson, E., Cato, I. (1980). Chemistry and Biogeochemistry of Estuaries. John Wiley & Sons. 4. Riley, J. P., Chester, R. (1978). Chemical Oceanography. Academic Press. 5. Dyer, K. R. (1986). Coastal and Estuarine Sediment Dynamics. Wiley. 6. Dyer, K. R. (1980). Estuarine Hydrography and Sedimentation. Cambridge University Press. 7. Hansell, D. A., Carlson, C. A. (2002). Biogeochemistry of Marine Dissolved Organic Matter. Academic Press. 8. Bianchi, T. S. (2007). Biogeochemistry of Estuaries. Oxford University Press.	
Learning Outcomes:	1. A comprehensive understanding of the properties and interactions of the substances present in the estuarine environment. 2. To gain knowledge on the key processes operating in the estuarine environment and importance of dissolved O_2, and pH. 3. To understand the nutrients cycling and air-water interactions in the estuarine environment.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–204
Title of the Course: Estuarine and Coastal Chemistry Practical
Number of Credits: 01

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To demonstrate the experiment involving analytical chemistry of the seawater.	
Content:	1. Spectrophotometric determination of dissolved inorganic phosphate in estuarine water byammonium molybdate – ascorbic acid method (6hours; Reference 1) 2. Spectrophotometric determination of nitrite in estuarine water by sulphanilamide – diamine method (6hours; References 1, 2) 3. Spectrophotometric determination of nitrate in estuarine water by reduction to nitrite using copper – coated cadmium reduction column (6hours; Reference 1) 4. Spectrophotometric determination of ammonia in estuarine water by indophenol blue method (6hours; References 1, 3) 5. Spectrophotometric determination of dissolved inorganic silicate in estuarine water by ammonium molybdate – ascorbic acid – oxalic acid method (6hours; Reference 1)	30hours
Pedagogy:	Laboratory experiments/ field studies	
References/ Readings:	1. Grasshoff, K., Ehrhardt, M., Kremling, K. (1983). Methods of Seawater Analysis. VerlagChemie, Weinheim. 2. Ewing, G. W. (1981). Instrumental Methods of Chemical Analysis. NY: McGraw-Hill. 3. Parsons, T. R., Maita, Y., Lalli, C. M. (1984). A Manual of Chemical and Biological Methods for Seawater Analysis. Oxford: Pergamon Press.	
Learning Outcomes:	1. To develop analytical skills to determine the concentrations of micro-nutrient elements (P, N and Si) in estuaries/aqueous systems. 2. To apply techniques to study the biogeochemistry of the estuarine/marine systems.	

Course Code:MSC–22–205
Title of the Course: Estuarine and Coastal Biology
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To provide an insight to carbon dioxide cycle in the estuarine and coastal environment with reference to anthropogenic inputs. Further, it deals with the estuarine and coastal ecosystem processes, including adaptations and fish migrations.	
Content:	**Module – I** Productivity in coastal and estuarine waters, Carbon cycle – production and transformation, Inorganic carbon, carbon – carbonate system, DOC sources, aerobic environments, processes, losses of organic carbon, processes, decomposers, anoxic environments – Fermentation, sulfate reduction, Methanogenesis, DOC internal and external sources, Role of phytoplankton in carbon export. **Module – II** Salt marsh ecosystem – species composition, distribution, nutrient dynamics, primary productivity and ecological processes and fate of salt marsh plant; Mangrove ecosystem species composition, distribution, adaptations, primary productivity, heterotrophic production, secondary communities and energy flow. Coral reef – types, calcification, nutrient dynamics, Nutrition in coral, benthic algae, role in calcification, total system function. Seagrass and seagrass beds – growth and reproduction, biodiversity and ecosystem benefits, habitat alteration, blue carbon, key functions, threats and conservation. **Module – III** Secondary production and estuarine ecosystem function, Heterotrophic processes and pathways, Plankton, nekton and benthic communities, adaptations (buoyancy, locomotion and defense) in coastal and estuarine plankton and nekton population, Fish migrations biology and energetics, Symbiosis in marine environment.	15hours 15hours 15hours
Pedagogy:	lectures/ tutorials/assignments/self-study	

References/Readings:	1. K. R. Dyer, John, 2012, Estuarine Ecology.2nd Edition,Wiley and Sons, New Jersey, USA. 2. James G. Wilson, 1988, The Biology of Estuarine Management, , Springer, London (UK). 3. Frances Dipper, R V TAIT, 1998, Elements of Marine Ecology, (4th Edition), Elsevier, Amsterdam, Netherlands. 4. P S Meadows; J I Campbell, 1988, An introduction to marine science, , Glasgow: Blackie; Halsted Press, New York. 5. N Balakrishnan Nair and D M Thampy, 1980, A textbook of marine ecology, Macmillan, New Delhi. 6. John H S Blaxter, Frederick Russell, Maurice Yonge (Editors), 1982, Advances in Marine Biology, 1st Edition, Academic Press (Elsevier), USA. 7. James W. Nybakken and Mark D. Bertness, 2005, Marine Biology: An Ecological Approach, 6th Edition Marine biology: An ecological approach (6th ed), –M. D. Pearson/Benjamin Cummings, San Francisco. 8. Mann, K. H., 2000, Ecology of coastal waters: with implications for management, 2nd edition, Blackwell Science, New Jersey, USA. 9. Valiela Evans, 1995, Marine Ecological Processes, , Springer Verlag, New York.	
Learning Outcomes:	1. Understanding of the processes related to the carbon cycle in the oceans and various processes influencing the estuarine and coastal biota and their adaptations.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–206
Title of the Course: Estuarine and CoastalBiology Practical
NumberofCredits:01

Prerequisitesf orthecourse:	Core courses offered in Semester I
Objective:	Identificationofcommonly occurringmarine organisms using morphologicalfeatures.

Content:	1. Identificationofmangroves,theirlifecycle andfewbiologicalcharacteristics(4 hours; References 1, 2, 3) 2. Identificationof hard corals and a few biologicalcharacteristics(6 hours; References 4, 5) 3. Identificationoffewcommonlyoccurringteleosts(ray-finnedfishes)andtheir biological characteristics(8 hours; References 6, 7, 8) 4. Identificationofbrachyurancrabsusingmorphologyandgonopodcharacteristics,sexdeterminationandtheirbiologicalimportance(4 hours; Reference 9) 5. Identificationofprawnsandshrimpsusing external characteristics,sexdetermination andbiologicalaspects(4 hours; Reference 9) 6. Morphometricmeasurements and meristiccountsof the IndianMackerel, *Rastrelligerkanagurta*(4 hours;Reference 10)	30 hours
Pedagogy:	Identificationofsampling devices,marinefloraandfauna	
References/Readings:	1. Untawale, A.G. (1985). Mangroves of India: present status and multiple use practices, UNDP/UNESCO Regional Mangrove Project, pp 67. 2. Dhargalkar, V.K., D'Souza, R., Kavlekar, D.P., Untawale, A.G.(2014). *Mangroves of Goa.* Forest department, Government of Goa and Mangroves society of India, Goa, India. 3. Hogarth,P.J. (2015).*Thebiologyofmangrovesandseagrasses*.OxfordUniversitypress. 4. De, K., Venkataraman, K., Ingole, B. 2019. The hard corals (Scleractinia) of India: a revised checklist. *Indian J Geo-Marine Science*, *40*(10):1651-1660. 5. Venkataraman, K., Satyanarayana, Ch., Alfred, J.R.B., Wolstenholme, J. (2003). *Handbook on hard corals of India*.Kolkata: Zoological Survey of India. 6. FAO species identification guide for fishery purposes. The living marine resourcesof the Western Central Pacific*., 1999b* – Carpenter K.E. & Niem V. H., *Volume 4.BonyFishesPart2(MugilidaetoCarangidae)*.(FoodandAgriculturalOrganization,Rome),pp. 2069– 2790. 7. FAO species identification guide for fishery purposes. The living marine resourcesof the Western Central Pacific*., 2001a* – Carpenter K.E. & Niem V.H. *Volume 5.BonyFishesPart3(MenidaetoPomacentridae)*.(FoodandAgriculturalOrganization,Rome),pp. 2791– 3380. 8. FAO species identification guide for fishery purposes. The living marine resourcesof the Western Central Pacific*., 2001b* – Carpenter K.E. & Niem V.H., *Volume6.Bony Fishes Part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles,sea snakes and*	

	marine mammals. (Food and Agricultural Organization, Rome), pp.3381– 4218. 9. FAO species identification guide for fishery purposes. The living marine resourcesof theWestern Central Pacific*, 1988b* – Carpenter K.E.& Niem V.H. *Volume2.Cephalopods,crustaceans,holothuriansandsharks*.(Food andAgriculturalOrganization,Rome),pp. 687– 1396. 10. Bhendarkar, M.P, Naik, S.D, Ramteke, M.H, Raut, S.M., Swain, S. (2014). Morphometric and Meristic studies of Indian Mackerel, *Rastrelligerkanagurta* (Cuvier, 1817) off Southern Coast of Maharashtra, India. *Ecology Environment and Conservation*, *20*(4), 1705– 1708.	
LearningOutcomes:	The course will provide an insight on morphological features of marine flora and fauna and their application in identification of commonly occurring species.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–207
Title of the Course: Estuarine and Coastal Geology
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To understand estuarine and coastal geology with respect to sub-divisions, morphological units and processes including sediment distribution and depositional environments.	
Content:	**Module I** Estuaries: Classification based on tide – geological classification and evolution – sub-environments in estuaries: mudflats, salt marsh, mangrove, salt pans – sediment source, transportation and deposition – bed and suspended sediment sampling and analysis – mineralogy and geochemistry of estuarine sediments. **Module II** Estuaries of the western coast of India. Metals and other pollutants – their seasonal variation andmetal variation with time in the mudflats and mangroves. Application of metals in paleo-monsoon, sea level changes and paleoenvironment. Health of estuaries – Impact of human activities on estuaries and restoration of estuaries. **Module III** Coasts: classification, types of coast with reference to Indian coast line – evolution of the Indian coast –	15 hours 15 hours

	global sea level changes: eustatic, tectonic and isostatic. Coastal signature of sea level changes. Coastal resources and coastal zone management, CRZ regulations and ICZM. Impact of floods, tsunamis and antropogenic interferences in coastal processes, coastal erosion, preparedness and precaution measures.	15 hours
Pedagogy:	Lectures / Assignments / Seminars / Discussion	
References/ Readings:	1. Burton, J. D., &Liss, P. S. (1976). Estuarine chemistry.London: Academic Press. 2. E., H.. (2009). P. C. Head (ed.). 1985. Practical Estuarine Chemistry. A Handbook. X + 337 pp. Cambridge, London, New York, New Rochelle, Melbourne, Sydney: Cambridge University Press. 3. Riley, & Chester, R. (1976). Chemical oceanography. Vol.5 edited by J.P. Riley and R. Chester (2nd ed.). Academic Press. 4. Wright, J., Colling, A., & Park, D. (Eds.). (1999). Waves, tides and shallow-water processes (Vol. 4). Gulf Professional Publishing 5. Dyer, K. R. (1986). Coastal and estuarine sediment dynamics. Chichester: Wiley. 6. Dyer, K. R. (1986). Estuarine hydrography and sedimentation, John Wiley & Sons. 7. Komar, P. D. (2018). Beach processes and erosion–An introduction. Handbook of coastal processes and erosion, 1-20. 8. Milliman, J. D., &Haq, B. U. (Eds.). (1996). Sea-level rise and coastal subsidence: Causes, consequences, and strategies (Vol. 2). Springer Science & Business Media. 9. Krauskopf, K. B., & Bird, D. K. (1967). Introduction to geochemistry (Vol. 721). New York: McGraw-Hill. 10. Tait, R. V., & Dipper, F. (1998). Elements of marine ecology. Butterworth-Heinemann.. 11. Meadows, P. S., & Campbell, J. I. (1988). An introduction to marine science. Glasgow: Blackie. 12. Balakrishnan, N. N., &Thampy, D. M. (1980). A textbook of marine ecology. Delhi: Macmillan. 13. Pethick, J. S. (1984). An introduction to coastal geomorphology. Dept. Of Geography, Univ. Of Hull. 14. Gotje, Wouter&Cleveringa, Jelmer&Steijn, Rob &Esselink, Peter. (2007). Restoration of estuarine habitats. What determines success or failure?. 10.13140/2.1.3414.6081.	
Learning Outcomes:	1. Understanding geology of estuarine and coastal sedimentary environments, processes and evolution. 2. Ability to understand and reconstruct estuarine and coastal environments.	

(Back to Index) (Back to Agenda)

Course Code:MSC–22–208
Title of the Course: Estuarine and Coastal Geology Practical
Number of Credits: 01

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To illustrate various methods involved in analysis of marine sediments, understand depositional environments and study of coastal geomorphological features	
Content:	1. Grain size analysis – sand, silt, clay using pipette method – estimation and interpretation – at least ten samples from a sediment core (12hours; References 1,5) 2. Determination of organic carbon – at least ten samples from a sediment core (4hours; References 1, 4,6) 3. Heavy mineral identification (4hours; References 1,2) 4. Study of depositional environments (4 hours; References 1, 2) 5. Study of coastal geomorphological features (Field work) (8 hours; Reference 7)	30hours
Pedagogy:	Laboratory experiments / Computations / Plotting and Interpretations and analysis/ Field Visit	
References/ Readings:	1. Friedman, G. M., & Johnson, K. G. (1982). Exercises in sedimentology. New York: Wiley. 2. Lindholm, R. C. (1987). A practical approach to sedimentology. London: Allen &Unwin. 3. Babu, S. K. &Sinha, D. K. (1987): Sedimentary Petrology Practical, CBS Pub., N. Delhi. 4. Carver, R. E. (1971). Procedures in sedimentary petrology. New York: Wiley-Interscience. 5. V.K. Verma and Prasad C (1981). A text book of Sedimentary Petrology Intl., Book Distribution. 6. Griffith, J. C., 1967, Scientific Methods in Analysis of Sediments: McGraw-Hill, New York, NY. 7. Monroe, J. S., Wicander, R., &Hazlett, R. W. (2007). Physical geology: exploring the earth (Vol. 584). Belmont: Thomson Brooks/Cole.	
Learning Outcomes:	1. To develop skill and ability for conduct of analysis of marine sediments. 2. Abillity to understand coastal geomorphology.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–209

Title of the Course: Geophysical Fluid Dynamics
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To impart an insight into different scales of motion in fluids (which includes both atmosphere and ocean) and to understand them by applying basic theorems and laws of fluid dynamics.	
Content:	**Module I** Basic concepts: fluid continuum, fluid properties, ideal fluid, types of flows; Scales of motions; Importance of rotation and stratification; Distinction between atmosphere and oceans. Statics: pressure surface and body forces on a fluid element; fundamental equation of fluid statics: application to compressible and incompressible fluids, hydrostatic equation along the vertical, application to the atmosphere, units of measurement; Newtonian and non- Newtonian fluids; Coriolis force; rotating frame of reference. **Module II** Kinematics: Lagrangian and Eulerian methods; stream lines, streak lines and trajectories; steady and non-steady flow; decomposition of the field of motion in the vicinity of a point; translation, rotation, divergence and deformation; Principles of Prandtl's mixing length theory; momentum budget; salt and moisture budget; summary of governing equations; Boussinesq approximation; typical flow patterns; stream function; divergence and vorticity in different co-ordinate systems; material, local and convective derivatives. Equation of continuity and its applications; non-viscous incompressible flow; Eulerian equations of motion; inertial and rotational frames of reference; irrotational flow; velocity potential; integration of the equations of motion; Bernoulli's theorem and its applications. **Module III** Circulation and vorticity; Stokes' theorem; Kelvin's theorem; Helmholtz's theorems; barotropic and baroclinic fluids; absolute and relative circulation; V. Bjerknes' circulation theorem and its interpretation; conservation of potential vorticity; Eddy coefficients; Important dimensionless numbers; turbulent	15hours 15hours 15hours

	diffusion; combination of advection and diffusion; geostrophic flow and vorticity dynamics; laminar flow of viscous incompressible fluids; turbulence in stratified flows; Reynolds number and dynamic similarity of flows; physical significance of Reynolds number; low and high Reynolds' number.	
Pedagogy:	Lectures/tutorials/assignments/ seminars	
References/Readings:	1. Cushman-Roisin, B., & Beckers, J.-M. (2009). *Introduction to Geophysical Fluid Dynamics– Physical and Numerical Aspects.* Academic Press 2. Modi, P. N., & Seth, S. M. (1985). *Hydraulics and Fluid Mechanics.* New Delhi: Standard Book House. 3. Yuan, S. W. (1969). *Foundation of Fluid Mechanics.* New Delhi: Prentice Hall. 4. Batchelor, G. K. (1967). *An Introduction to Fluid Mechanics.* U.K.: Cambridge University Press. 5. Lamb, H. (1975). *Hydrodynamics.* U.K.: Cambridge University Press. 6. Rathy, R. K. (1976). *Introduction to Fluid Mechanics.* Oxford and IBH Publishing Company, New Delhi. 7. Roll, H. U. (1965). Physics of the marine atmosphere. *International Geophysics Series*, Vol. *7*. [Ed.] J. Van Miegham. London: Academic Press. 8. Gill, A. E. (1982). *Atmosphere- Ocean Dynamics.* International Geophysics Series, Volume 30. New York: Academic Press. 9. Vallis, G. K. (2009). *Atmospheric and Ocean Fluid Dynamics– Fundamentals and Large-Scale Circulation.* Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo: Cambridge University Press. 10. Pedlosky, J. (1987). *Geophysical Fluid Dynamics (Second Edition).* New York, U.S.A.: Springer.	
Learning Outcome:	An ability to better understand the basic geophysical fluid dynamical processes.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–210
Title of the Course: Geophysical Fluid Dynamics Practical
Number of Credits: 01

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To acquaint with a hands-on-experience based on learnings in the theory. It involves field-based observations and numerical techniques.	
Content:	1. Kinematics analysis of wind and ocean current – Isotach and isogon analysis and construction of streamline patterns (5 hours; Reference 1) 2. Construction of trajectories of air parcels from successive synoptic charts (5 hours; Reference 1) 3. Computation of divergence and vorticity in horizontal flow (5 hours; Reference 2) 4. Construction of stream lines for simple types of flow (5 hours; Reference 2) 5. Analysis of physical oceanographic parameters of estuarine waters using data of conductivity temperature and depth (CTD) instrument (5 hours; References 1, 3) 6. Analysis of aerosol trajectory using HYSPLIT (Hybrid Single – Particle Lagrangian Integrated Trajectory) model. (5 hours; References 4, 5)	30hours
Pedagogy:	Tutorials/ assignments/ practical/ field study	
References/ Readings:	1. Stewart, R. H. (2008). *Introduction to physical oceanography*. Robert H. Stewart. https://open.umn.edu/opentextbooks/textbooks/20 2. Guide to Wave Analysis and Forecasting. (2018). *World Meteorological Organization (WMO-No. 702).* ISBN 978-92-63-10702-2. www.wmo.int/pages/prog/amp/mmop/documents/WMO%20No%20702/WMO702.pdf ; https://library.wmo.int/doc_num.php?explnum_id=10979 3. Siedler, G., Griffies, S., Gould, J., & Church, J. (2013). *Ocean Circulation and Climate– A 21st Century Perspective.* Academic Press. 4. HYSPLIT- Hybrid Single Particle Lagrangian integrated Trajectory Model, Air Resources Laboratory, http://www.arl.noaa.gov/ . 5. Draxler, R. R., & Hess, G. D. (2020). *Description of the Hysplit_4 Modelling System; NOAA Technical Memorandum ERL ARL- 224. 1997, (Revised 2020).* Silver Spring, Maryland, U.S.A.: Air Resources Laboratory. https://www.arl.noaa.gov/documents/reports/arl-224.pdf 6. Roll, H. U. (1965). Physics of the marine atmosphere. *International Geophysics Series*, Vol. 7. [Ed.] J. Van Miegham. London: Academic Press. 7. Gill, A. E. (1982). *Atmosphere- Ocean Dynamics.* International Geophysics Series, Volume 30. New York: Academic Press.	
Learning outcome:	To develop an ability to analyse flow patterns and an awareness of HYSPLIT online tool.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–211
Title of the Course: Marine Pollution
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To provide an insight on the type of pollutants,sources and impact on marine life. Also, to learn conservative (radioactive pollutants, trace metals and pesticides) and non-conservative pollutants (oil and other organic wastes). Quantification of pollutant through suitable indicator organisms and monitoring strategies.	
Content:	**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; Thames and Mersey estuary; Consequences of sludge dumping at sea with reference to Thames and Firth of Clyde. Sewage treatment: Primary, Secondary and Tertiary treatment processes. Solid waste pollution: Classification and disposal of solid wastes.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 in the world (pollution aspect); The North sea, The Mediterranean sea and the Baltic sea. **Module 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).The present status of coastal pollution in India and future strategies. Radioactive Pollution: Sources, Classification and effects of radiation; Protection and control from radiation: Maximum permissible dose concept,	15hours 15hours

	dose limits, Disposal of radioactive wastes; Beneficial aspects of radiation and food safety. **Module III** Indicator organisms: Criteria for selection of indicator organism: Quantification of pollution load, basic pre-requisites, response to different pollution load and time integration capacity, Macro algae, crustaceans and mollusks as indicator organisms for monitoring of trace metal pollution; Red tides: distribution, types of poisoning, effects and methods to minimize red tides in the sea. Monitoring strategies of marine pollution: Critical pathway approach and Mass balance approach. Standards in water quality: Assessment of pollution damage: The need, seriousness of damage, assessment of damage and problems of measuring impact.	15hours
Pedagogy:	lectures/ tutorials/assignments/self-study	
References/Readings:	1. Riley J.P and Skirrow, G (1975). Chemical Oceanography(3) Riley J.P and Skirrow, G. (eds.), Academic press, New York. 2. Goldberg, E.D (1976). The health of the oceans. UNESCO Press. 3. Clark, R.B (1986). Marine Pollution. Oxford science Publications. 4. Phillips J.D.H (1980). Quantitative aquatic biological indicators Applied Science Publishers. 5. Sharma, B.K and Kaur, H. Krishna (1994). Thermal and radioactive pollution,Prakasham Mandir (pub) Meerut. 6. B. K and Kaur, H. Krishna (1994).Water Pollution, 1994 – Sharma Prakasham Mandir (pub), Meerut. 7. Chandler, K.A. (1985). Marine Offshore corrosion, Butter Worths (pub) London.	
Learning Outcomes:	1. To understand the impact of various pollutants on marine ecosystems. 2. To create awarenessto safeguard themarine environment through identification of factors responsible for causing marine pollution and to suggest policy measures to prevent marine pollution.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–212
Title of the Course: Marine Pollution Practical
Number of Credits: 01

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	To analyze the concentration of various pollutants in the seawater and their effect on marine life includingBOD and COD to assess the impact of organic pollution.	
Content:	1. Determination of dissolved oxygen in polluted waters. (5 hours; Reference 1) 2. Determination of biochemical oxygen demand in polluted waters. 5 hours; Reference 1) 3. Determination of chemical oxygen demand in polluted waters. (5 hours; Reference 2) 4. Pre-concentration of water for estimation of trace metals by AAS(5 hours; References 5,6,7) 5. Estimation of Cd in polluted waters and biological sample. (5 hours; References 5,6,7) 6. Estimation of Cu in polluted waters and biological samples. (5 hours; References 5,6,7)	30hours
Pedagogy:	Demonstations/ Labexperiments.	
References/Readings:	1. Martin, D.F (1972). Marine Chemistry (01). Academic Press, London. 2. Rice, E.W and Bridgewater L. American (2012).Standard methods for the examination of water andwaste water analysis (22nd edition), Public healthassociation, Washington DC. 3. Grasskhoff, K, M (1983). Methods of Seawateranalysis. Ehrdardt and K. Krembling (eds.), Verlag Chemie, Weinneim. 4. Strickland, J.D.H, and Parsons, T.R (1972) A practical hand book of seawater analysis.Fisheries Board of Canada bulletin. (2nd edition). 5. Riley, J.P. and Skirrow, G (1975). Analytical chemistry of seawater, In Chemical Oceanography (03), Riley, J.P. and Skirrow, G (eds.). Academic Press, London. 6. Allen, S. E., Grimshaw, H. M., Parkinson, J. A., Quarmby, C. And Roberts, J.D. (1976). Chemical Analysis. In: Methods in plant Ecology, S. B. Chapman (eds.), Blackwell Scientific Publications, Oxford, Chapter 8.	
Learning Outcomes:	1. To apply the results of analyses of different pollutants to draw valid inferences affecting marine life.	

Course Code:MSO–22–213
Title of the Course: Marine Microbial Ecology
NumberofCredits:03

Prerequisitesf orthecourse:	Core courses offered in Semester I	
Objective:	To provide basic information and concepts of marine microbiolog and its importance to enable identification of microbes from marine environments.	
Content:	**Module I** Marinemicrobiologyitsimportance andneed;Historyofmarinemicrobiology; Instrumentsandsamplingmethods; Sampling strategiesandmethodsfor assessment ofmicrobialbiodiversity; Microbialhabitatsandmajortypes (producers,consumers,symbionts, etc.)inrelationtotheirhabitats;Characteristics of marine microbes; Distribution and abundance and their adaptations to pressure,depth,salt,temperature;Chemosynthesisandmicrobial heterotrophicmetabolism.	15hours
	Module II Microbialroleincyclingof N,P andS;Integratedeffectsofnutrientdynamics;Effectofionsofmajoran dtraceelements;Toxicity andmechanismof toleranceinmarinemicrobes;Conceptofmicrobialloopinrelationtom arinefoodwebdynamics; Role of microorganisms in DOM production and consumption; RoleofmarinemicrobesinproductionofRDOC andsequesteringofcarbondioxide; Pollution indicator and pathogenic marinemicrobes.	15hours
	Module III Biochemicalcharacterizationofmarineprokaryotes; Meta-genomic analysis; Principles andapplicationsof TFFformicrobialmolecularanalysis; Principles and methods of DNA/RNA extraction,PrincipleandapplicationsofPCR;GELelectrophoresis,DN Apurificationandvisualization techniques; Bioinformatics for marine molecular analysis – principles of phylogenictree, BLAST analysis, search tools; sequence data base; Application of different statistical test(Shannon – Wiener diversity index, Simpson index, species richness, Chao, ACE indices)formicrobialdiversityanalysis.	15hours
Pedagogy:	Lectures/tutorials/assignments/self-study	

References/Readings:	1. Gasol, J.M. &Kirchman, D.L. (Eds.) (2018). *Microbial Ecology of the Oceans* (2nd ed). John Wiley&Sons. 2. Munn,C.(2020). *MarineMicrobiology: Ecology & Applications* (3rd ed). CRC Press.. 3. Hunter-Cevera, J., Karl, D., Buckley, M. (2005). *Marine Microbial Diversity: The Key to Earth's Habitability*. This report is based on a colloquium, sponsored by the American Academy of Microbiology, held April 8–10, 2005, in San Francisco, California. Washington (DC): American Society for Microbiology. 4. Meller,C.B.,&Wheeler,P.A. (Eds.)(2012). BiologicalOceanography (2nd ed),Wiley–BlackwellPublishers. 5. Oliver, J.D.(1982). Taxonomic scheme for the identification of marine bacteria. *Deep Sea Res*earch Part A. Oceanographic Research Papers*29*(6), 795–798. 6. Valiela, I. (1995).*Marine Ecological Processes* (2nd ed). Springer-Verlag, New York. 7. Belkin,S., &Colwell,R.R. (Eds.) (2005). *OceanandHealth:Pathogens inthemarineEnvironment*. Springer–Verlag,NewYork. 8. Kennedy, J., Flemer, B., Jackson, S.A., Lejon, D.P.H., Morrissey, J.P., O'Gara, F., Dobson, A.D.W. (2010). Marine Metagenomics: New Tools for the Study and Exploitation of Marine Microbial Metabolism. *Marine drugs 8,* 608-628. 9. Lear, G., Dickie, I., Banks, J., Boyer, S., Buckley, H. Et al. (2018).Methods for the extraction, storage, amplification and sequencing of DNA from environmental samples. *New Zealand Journal of Ecology42*(1): 10.	
LearningOutcomes:	1. The student will develop and provide information on marine microbial ecology. 2. It will help in applications ofclassical and molecular methodstounderstandecologicalprocesses.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–214

Title of the Course: Marine Microbial Ecology Practical

NumberofCredits:01

Prerequisites for the course:	Core courses offered in the Semester I
Objective:	To elucidatebasicconceptsandtechniquesappliedinmarinemicrobiology.

Content:	1. Sterilizationtechniques,preparationofbacterialmedia – nutrient agar plates, nutrient broth&agarslants(6 hours;Reference 1). 2. Methodofsamplecollection(water)frommarineenvironment (3 hours;Reference 2). 3. Enumeration and isolation of heterotrophic bacteria, pathogenic organisms and/orfungalpopulationfromwater andsedimentswithreferencetophysico-chemicalconditions(6hours;References 3, 4, 5). 4. Isolationofpurecultures for microscopy:wetmounts(3 hours;Reference 4). 5. Separationofmixedculture,isolation,maintenanceandpreservationofpureculture(4 hours;Reference 3). 6. Staining ofbacteriaandcellmorphology(2 hours;Reference 1). 7. Characterization,biochemicaltests and identificationofmarine bacteria (6 hours;Reference 1).	30hours
Pedagogy:	Laboratorytechniques/practical/demonstrations/field studies.	
References/Readings:	1. Bergey, D.H., Krieg N.R., & Holt, J.G. (1984). *Bergey'smanualofsystematicbacteriology(Vol.I)*. William&Wilkins,Baltimore. 2. Colwell, R.R. (1975). *Marineandestuarinemicrobiologylaboratorymanual*. UniversityParkPress. 3. Zobell, C.E.(1946). *Marinemicrobiology,amonographonhydrobacteriology*.ChronicaBotánica Company, Waltham, Mass. 4. Harigan,W.F., &McCance,M.E. (1966). *Laboratorymethodsinmicrobiology.*Academic Press, London, New York. 5. Hurst,G.J.,&Knudsen,G.R.(1997) *Manualofenvironmentalmicrobiology*. ASM Press, Washington, D.C.	
LearningOutcomes:	The student will get acquainted with some of the basic methods and techniques to study microbiology of the marine environment.	

(Back to Index) (Back to Agenda)

Course Code:MSO–22–215
Title of the Course: Sedimentology
Number of Credits: 03

Prerequisites for the course:	Core courses offered in the Semester I.
Objective:	To learn sediment types and their distribution, concept of facies, heavy mineral zones, sedimentary depositional environments, sedimentary rocks and diagenesis.

Content:	**Module I** Sedimentary rocks – Classification, properties, origin and importance – Sandstone, Limestone, mudstones and evaporites. Distribution and genesis of terrigenous, bio-genous, chemo-genous, volcanogenic, authigenic and extraterrestrial (cosmogenous) sediments in the world ocean – Rate of sedimentation in the oceans. **Module II** Concepts of sedimentary facies, facies construction and interpretation, factors controlling the nature and distribution of facies – Provenance – Heavy minerals, rock particles and clay minerals – Mineral stability – Goldich stability series, sediment maturity – X ray diffraction technique and its use in mineral and sediment study. **Module III** Sedimentary structures– Diagenesis: general considerations, terrigenousclastic sediments, carbonate sediments, evaporates and hydrocarbons. Sedimentary depositional environments – Aeolian, lacustrine, glacial desert, fluvial, coastal shallow marine and deep sea – Sedimentary and faunal markers of paleoenvironmental conditions. Biostratigraphy and its applications.	15 hours 15 hours 15 hours
Pedagogy:	Lectures / Assignments / Seminars / Discussion	
References/Readings:	1. Lisitzin, A. P., & Rodolfo, K. S. (1972). Sedimentation in the world ocean: with emphasis on the nature, distribution and behavior of marine suspensions. 2. Leeder, M. R. (1982). Sedimentology Process and Product, Departement of Earth Sciences, University of Leeds. 3. Pettijohn, F. J. (1957). Sedimentary rocks. New York: Harper. 4. Krumbein, W. And Sloss, L. (1963) Stratigraphy and Sedimentation. W.H. Freeman and Co., San Francisco 5. Reading, H. G. (1986). Sedimentary Environments and facies 2nd edition. Blackwell Scientific Publications, Oxford, 6, 15. 6. Reineck, H. E., & Singh, I. B. (2012). Depositional sedimentary environments: with reference to terrigenousclastics. Springer Science & Business Media.. 7. Blatt, H., Middleton, G. V., & Murray, R. C. (1972). Origin of sedimentary rocks. 8. Friedman, G. M., & Sanders, J. E. Principles of Sedimentology, 1978., John Wiley & Sons. 9. Carver, R. E. (1971). Procedures in sedimentary petrology. John Wiley & Sons Incorporated. 10. Allen, J.R.L. (1982) Sedimentary Structures: Their Character and Physical Basis. Vol. 1. Developments in Sedimentology. Elsevier,	

	Amsterdam. 11. Allen, J. R. (1970). Physical processes of sedimentation. American Elsevier Pub. Co.. 12. Selley, R. C. (1970). Ancient sedimentary environments., Chapman & Hall. 13. Pettijohn, F. J., & Potter, P. E. (2012). Atlas and glossary of primary sedimentary structures. Springer Science & Business Media. 14. Pettijohn, F. J., Potter, P. E., &Siever, R. (1972). Sand and Sandstone. Springer-Verlag, Berlin Heidelberg New York.
Learning Outcomes:	1. Understanding sediment processes, paleo-environments, formation. 2. Ability to reconstruct paleo-climate and paleo-environments.

(Back to Index) (Back to Agenda)

Course Code:MSO–22–216
Title of the Course: Sedimentology Practical
Number of Credits: 01

Prerequisites for the course:	Core courses offered in the Semester I.	
Objective:	This course introduces to experiments to analysis to understand depositional environments and processes and todemonstrate basic methods for analysis of marine sediments.	
Content:	1. Measurement of sphericity and roundness of sediment grains (6hours; References 1,2). 2. Identification of sedimentary rocks (4hours; References 3,7). 3. Identification of sedimentary structures (4hours; References 3,4). 4. Study of sedimentary facies (4hours; References 4,5). 5. Preparation of samples for X-ray diffraction analysis (4hours; References 4,6). 6. XRD analysis for clay minerals, Clay mineral identification and estimation of Semiquantitative percentages and interpretation (4hours; References 4,6). 7. Paleocurrent analysis (4 hours; Reference 4).	30 hours
Pedagogy:	Laboratory experiments/Computations/ Plotting and interpretations and analysis.	
References/ Readings:	1. Friedman, G. M., & Johnson, K. G. (1982). Exercises in sedimentology. New York: Wiley. 2. Lindholm, R. C. (1987). A practical approach to sedimentology. London: Allen &Unwin. 3. Babu, S. K. &Sinha, D. K. (1987): Sedimentary Petrology Practical, CBS Pub., N. Delhi. 4. Carver, R. E. (1971). Procedures in sedimentary petrology. New York: Wiley-Interscience. 5. K. Verma & Prasad C. (1981). A text book of Sedimentary Petrology Intl., Book Distribution 6. Griffith, J. C., 1967, Scientific Methods in Analysis of Sediments: McGraw-Hill, New York, NY. 7. Moorhouse, W. W. (1959). The study of rocks in thin sections: by WW Moorhouse. Harper. 8. Read, H. H. (1970). Rutley's elements of mineralogy. London,UK: Thomas Murby& Co.	
LearningOutcomes:	1. To generate data and analyze to understand facies, paleo-current, sedimentary structure and depositional environments. 2. Ability to interpret data sets to understand sedimentological processes.	

(Back to Index) (Back to Agenda)