GOA UNIVERSITY
DEPARTMENT OF MARINE SCIENCES

Syllabus for M. Phil. in Marine Sciences

Effective from 2013-2014; Approved in the Academic Council – Standing Committee held on 16.05.2013

Course Structure

SEMESTER I

Paper Code	Paper Title	Marks ISA + SEA
MSP 101	Research Methodology	50+50
MSP 102	Marine Processes I	50+50
MSP 103	Marine Processes II	50+50

SEMESTER II

Paper Code	Paper Title	Marks
MSP 201	Dissertation	200

SYLLABUS

MSP 101 Research Methodology

Module I

Research methods in oceanography - field surveys - mooring and monitoring - procedures and protocols followed in oceanographic observations and sampling - calibration of equipments - data analysis.

Hypotheses, mathematical modelling and statistical tools used for processing oceanographic data. Basics of advanced instrumentation required for physical oceanographic studies, remote sensing.

Skills for research communication, scientific ethics (authorship – plagiarism - multiple, duplicate, concurrent publications / simultaneous publication - research results misappropriation) and scientific manuscript preparation.

List of Books / References

1. Light and Photosynthesis in aquatic ecosystems, 1983 – John T.O Kirk, Cambridge University press, London.
2. Statistical analysis in Climate research, (2004) Hans Von Stroch and Frankes Vol II, Cambridge press.
3. Principal component analysis, 2002. 2nd Edition, Jolliffe I.T, Springer.
4. A Users guide to Principal component analysis (1991), Jackson J.E. John Wiley and Sons Inc.
5. The scientific attitude, (1992), Grinnel F, The Guildford press, New York.
6. The Chicago guide to communicating science (2003). Univeristy of Chicago Press, Chicago.
7. Scientific values: ethical guidelines and procedures (2005), Indian Academy of Sciences.

Module II

Research methods, techniques and protocols followed in water sampling, pre-treatment methods, preservations and analysis.

Errors in analytical measurements, accuracy, precision and validation of analytical data, intercalibration of analytical methods and reference standard materials. Field and laboratory equipments used in Marine Chemistry.

Safety practices in chemical laboratory, disposal of chemical wastes, handling of hazardous gases and chemicals, fire safety and first aid.

List of Books / References

1. Chemical Oceanography (1975). Edited by J.P. Riley and G. Skirrow. Academic Press London.
2. Methods of seawater analysis (1983). Edited by K. Grasshoff, M. Ehrhardt and Kremling. Published by Verlag Chemie.
3. Manual for the geochemical analyses of marine sediments and suspended particulate matter (1992). Edited by D.H. Loring and R.T.T. Rantala. Elsevier Science publishers.
4. Instrumental Methods of Chemical Analysis (1976) by G. W. Ewing.
5. Practical Estuarine Chemistry (1985) by P. C. Head.
6. The Chicago guide to communicating science (2003). Univeristy of Chicago Press, Chicago

Module III

Research methods, techniques and protocols followed in biological sampling, preservations, documentation and identification. Field and laboratory equipments used in Marine Biology.

PRIMER software (Hierarchical clustering – dendrograms; Ordination by Principal Components (PCA) and non-metric Multi-dimensional scaling (MDS); Permutation-based hypothesis testing (ANOSIM); plotting of species abundance distributions).

Safety practices in biological laboratory, biosafety and ethical components associated with experimental animals – marine organisms, handling of pathigens and microbes, Good microbiological practices (GMP).

List of Books / References

1. Biological Oceanography 1999 – Lalli, C.M.
2. Methods in marine zooplankton ecology, 1984 Omori, W. and Ikeda, T.
3. Methods for the study of marine benthos, 1984 – Holme, N.A. & Melntyre, A.D.
4. Guides to the identification on marine and estuarine invertebrates, 1971- Grossner, K.L.
5. Fishes of India, 1967 – Day, F.
6. Zooplankton Methodology Manual, 2000 - Harris, R., Wiebe, P., Lenz, J., Skjoldal, H.R., Huntley, M. (Eds), ICES Academic Press, San Diego, pp. 684.
7. Biometry, 1981 – Sokal, R.R. and Rohlf, F.J. Freeman & Co. San Fransisco.
8. Statistical methods, 1967 – snedecore, G.W. and Cochran, W.G.,Allied Pacific Pvt. Ltd., Mumbai.
9. Multivariate statistical methods, 1990 – Morrison, D.F., Mc.Graw-Hill Publ.,Singapore.

Module IV

Research methods, techniques and protocols followed in sediment sampling, preservations and analysis. Field and laboratory equipments used in Marine Geology and Geophysics.

Geological, geochemical and geophysical exploration, experimentation, reconstruction of paleoclimate and earth history.

Good practices in laboratory record keeping, project proposal writing. Safety practices in geological laboratory, Radio isotope safety, safety legislation.

List of Books / References

1. Exercises in sedimentology, 1982 – Friedman, G.M. & Johnson, K.G.,John wiley & sons.
2. A practical approach to sedimentology, 1987 – Lindholm, R., C.B.S. Publ. And Distr.
3. Scientific method of analysis of sediments, 1967 – Griffiths, J.C., McGraw-Hill.
4. Chicago guide to communicating science, 2003. The University of Chicago press, Chicago . Montgomery, S. L.
5. Scientific values: Ethical guidelines and procedures, 2005. Indian Academy of Sciences.
6. Research papers published in scientific journals – last five years.

MSP 102 Marine Processes I

Module I

Physical properties of sea water and their distribution – geophysical fluid dynamics – Wind -Thermohaline and Tidal forcing- Coastal and inland water circulation - Wind and tidal waves –generation and propagation in shallow waters - coastal and estuarine processes – Electromagnetic Radiation – properties and propagation - Visible light – interaction with atmosphere and shallow water – aerosol optical depth (AOD) -attenuation of light – Downwelling irradiance - Photosynthetically available radiation (PAR) – optically active constituents in sea water- absorption and scattering – diffuse attenuation coefficient – Euphotic depth – Optical remote sensing.

List of Books / References

1. Descriptive Physical Oceanography: An introduction, 1989 - Pickard, G.B. and Emery, W.J., pergamon press, U.K.
2. Introduction to satellite oceanography, 1985 – Maul, G.A., Martinus Nijhoff Publ.
3. Advanced remote sensing from theory to applications (vol.1,2 & 3), 1981 – Chlamys, F.T., Addision wisley Publ. Co. Inc., Canada.
4. Light and photosynthesis in aquatic ecosystems, 1983- John T.O. Kirk Cambridge Univrsity press, London.
5. Optical properties and remote sensing of inland and coastal waters, 1995- Bukata R P, Jerome J H , Kondratyev K Y and Pozdnyakov D V. CRC Press.

Module II

Sea - a source of raw material: Extraction of inorganic and organic materials - salt, fresh water, Agar, carrageenan, alginic acid, nitrogenous compounds and organic toxins.

List of Books / References

1. Pollution of the oceans in Marine chemistry and Geochemistry (2009) compiled by Karl K. Turekian. Academic Press.
2. Marine Pollution (1986). Edited by R. B. Clark. Oxford Science Publications.
3. Chemical Oceanography (1975). Edited by J.P. Riley and G. Skirrow. Academic Press London.
4. Methods of seawater analysis (1983). Edited by K. Grasshoff, M. Ehrhardt and Kremling. Published by Verlag Chemie.

Module III

Life history characteristics of marine organisms - life stages, development, maturity, fecundity.

Biological processes of coastal organisms – habitat selection, settlement, grazing, predation, migration, spawning.
Meio-fauna and macro-fauna – community structure, niche differentiation, roles in trophic web.

Fish and shellfish – community structure, spatio-temporal patterns of abundance and distribution.

List of Books / References

1. Marine biology. An ecological approach (1988; 2nd edition) by Nybakken, J. W. N.Y., Harper & Row, 514 pp.

2. S. S. Kulkarni, C. U. Rivonker and U. M. X. Sangodkar (2003) Role of meio-benthic assemblages in detritus based food chain from estuarine environment of Goa, west coast of India during post – monsoon season. *Indian Journal of Fisheries*, 50(4): 465-471.
3. Azra Ansari, C. U. Rivonker and U. M. X. Sangodkar (2001) Population fluctuation and vertical distribution of meio-fauna on a tropical mudflat. *Indian Journal of Marine Sciences*, 30 (4): 237-245.
4. C. U. Rivonker and U.M.X. Sangodkar (1997) Macro-faunal composition and biomass of sandy beaches of Lakshdweep atolls with respect to tar balls. *Indian Journal of Fisheries*, 44 (4): 345- 352.
5. Z. A. Ansari, A. Chatterjee, B. S. Ingole, R. A. Sreepada, C. U. Rivonker and A. H. Parulekar (1995) Community structure and seasonal variations of an inshore demersal fish population of Goa, west coast of India. *Estuarine, Coastal and shelf Science*, 41: 593 – 610.
6. C. U. Rivonker, Z. A. Ansari and A. H. Parulekar (1993) Cultivation of green mussel, *Perna viridis* L. on a floating raft in an estuary, along the west coast of India. *Aquaculture*, 112: 47-56.
7. C. U. Rivonker, R. A. Sreepada and A. H. Parulekar (1992) Growth parameters in the cultured green mussel, *Pernaviridis* L. from the Zuari estuary, Goa. *Indian Journal of Marine Sciences*, 22: 72-74.
8. Z. A. Ansari, C. U. Rivonker, Prita Ramani and A. H. Parulekar (1991) Comparative micro-faunal abundance in seagrass meadows of Lakshdweep atolls, Arabian Sea. *Coral Reef*, 10: 127-131.
9. Z. A. Ansari, Prita Ramani, C. U. Rivonker and A. H. Parulekar (1991) Macro and meio-faunal abundance in the six sandy beaches of Lakshadweep Island – A comparative account. *Indian Journal of Marine Sciences*, 19: 159-164.

Module IV
Earth, Geological time scale, Ocean morphology, Plate tectonics.

Geophysical and geochemical methods in exploration.

Depositional environments, sediments, pathways, sedimentary processes, sedimentary facies.

Geochemical classification of elements, geochemical cycle, factors in sedimentation.

List of Books / References

1. Introductory oceanography (5th ed),1988 Thurman,H.V., Mercill Publ. Co, Ohio.
2. Oceanography (5th ed), 1990 –Grant Gross, M., Prentice Hall.
3. Marine geology and oceanography of the Arabian Sea and coastal Pakisthan 1984 – Haq. B.U. and Milliman, J.D., Van Norstrand Reinhold Co.
4. Introduction to geophysical prospecting, 1976 – Dobrin, M.B., McGraw-Hill.
5. Gravity and magnetics in oil prospecting , 1976 – Nettleton, L.L., McGrw-Hill.
6. Sedimentation in the world ocean, 1972 – lisitzin, A.P., Soc. of E.C. Paleontologists.
7. Depositional sedimentary environments, 1986- Reinek, H.E. and Singh, I.B., Springer Verlag.
8. Principles of sedimentology, 1978 – Friedman, G.M. and sanders, J. E., John Wiley & Sons.
9. Introduction to geochemistry, 1967 Krauskopf, K.B.,Mc.Graw-hill.
10. Geochemistry, 1962 – Goldschmidt, V.M., Clarendon press.
11. Principles of geochemistry 1956 – Mason, B. and Moore, B.
12. Chemical oceanography (Vol. 1 & 3), 1975 – Riley, J.P. and Skirrow, G.
13. Introduction to geochemistry, 1995 – Krauskopf, K.B. and Bird, Mc-Graw Hill.
14. Ocean chemistry and deep sea sediments, 1989 – Open University Course Material.

MSP 103 Marine Processes II

Module I

Ocean-atmosphere coupled system

Indian summer Monsoon: spacial & temporal variability- Linkage with ElNinoso, North Atlantic Oscillation, India Ocean Dipole zonal model.

Atmospheric Stability: Lapse rate - dry adiabatic lapse rate- moist adiabatic lapse rate – absolute stability- stability of inversion layer- absolute instability- conditional instability. Atmospheric stability & precipitation.

Western distrubance: origin, role of upper troposhere in development of W. D. movement, impact.

List of Books / References

1. Tropical Meteorology Vol I, II & III. (2005 2nd Edn): G. C. Asnani.. Published by G. C. Asnani.

2. An introduction to Dynamic Meteorology (2003).James R. Holton & Gregory J. Hakim. Elsevier Academic Press.
3. Synoptic Dynamic Meterorology in Midlatitudes. Vol II (1993): Bluestein H.: Oxford University press. New York.
4. An Introduction to Boundary Layer Meteorology (1988): Stull, R.B. Springer.

Module II

Marine biogeochemical cycles; Biogeochemistry of marine environments; Biogeochemical processes in estuaries; colloidal system; Sorption models for dissolved and particulate matter in estuarine waters.

List of Books / References

1. Introduction to Marine Biogeochemistry (2009) by S. M. Libes.
2. Chemical Oceanography (Vol. 2 and 3) (1975) by J. P. Riley and G. Skirrow.
3. Biogeochemistry of Estuaries (2009) by T. S. Bianchi.
4. Treatise on Estuarine and Coastal Science (Vol. 5) (2012) by E. Wolanski and D. McClusky.
5. S. Upadhyay (2008). Sorption model for dissolved and particulate aluminum in the Conway estuary, UK. Estuarine, Coastal and Shelf Science, 76, 914-919.
6. S. Upadhyay (2012). Sorption model for dissolved and leachable particulate aluminum in the Great Ouse estuary, England. Aquatic Geochemistry, 18, 243 – 262.

Module III

Taxonomic identification of marine organisms (commercial fishes and by-catch organisms), morphometric and meristic techniques - C*harybdis goaensis, Scylla olivacea, Caesio cuning, Temnopleurus decipiens, Morula anaxeres,* Sea snakes.

Biodiversity and current status, Biogeography of marine organisms. Biodiversity and determinants and ecosystem function.

Threats to marine biodiversity - climate change and anthropogenic inputs, fishing through food webs, habitat alteration and destruction, invasive species.

List of Books / References

1. Marine Biodiversity - Pattern and Processes, edited by Rupert F.G. Ormond, John.D.Gage and Martin.V.Angel, Cambridge University press (1997): pp449.
2. *Raghukumar, S. and Anil, A.C. (2003)* Marine biodiversity and ecosystem functioning: A perspective. *Current Science, 84(7): 884-892.*

3. M. R. Hegde and C. U. Rivonker. A new record of *Temnopleurus decipiens* (de Meijere, 1904) (Echinoidea, Temnopleuroida: Temnopleuridae) from Indian waters. *Zoosystema* (in press).
4. V. P. Padate, C. U. Rivonker and A. C. Anil. A new record of *Scylla olivacea* (Decapoda, Brachyura, Portunidae) from Goa, central west coast of India – A comparative diagnosis. *Indian Journal of Geo-Marine Sciences* (in press).
5. J. V. Kumbhar and C. U. Rivonker (2012). A new record of *Morula anaxares* with a description of the radula of three other species from Goa, Central west coast of India (Gastropoda: Muricidae). *Turkish Journal of Fisheries and Aquatic Science*, 12: 189–197.
6. V. P. Padate, C. U. Rivonker, A. C. Anil, S. S. Sawant and K. Venkat (2010) A new species of portunid crab of the genus *Charybdis* (De Haan, 1833) (Crustacea: Decapoda: Brachyura) from Goa, Central West coast of India. *Marine Biology Research*, 6: 579–590.
7. V. P. Padate, C. U. Rivonker and A. C. Anil (2010) A new record of the reef inhabiting fusilier *Caesio cuning* (Bloch, 1791) off Goa, West coast of India. *Marine Biodiversity Records, Marine Biological Association of the United Kingdom*, e3: 1-6.
8. V. P. Padate, L. V. Baragi and C. U. Rivonker (2009) Biological aspects of sea snakes caught incidentally by commercial trawlers off Goa, west coast of India. *Journal of Threatened Taxa*, 1 (12): 609-616.

Module IV

Estuaries and coasts - processes.

Fundamentals of mineralization, ocean mineral resources – phosphorites, carbonates, oil & gas, polymetallic nodules, gas hydrates.

Climate change linked to ocean processes –short and long term. Proxies for climate change studies. Sea level variations.

List of Books / References

1. Coastal and estuarine sediment dynamics, 1986 – Dyer,K.R., John Wiley & Sons.
2. Beach processes and sedimentation, 1976 – Komar, P.D., Prentice Hall.
3. Beaches and Coasts (2nd ed), 1972 – King, C.A.M.,Edward Arnold.
4. Estuarine chemistry, 1976 - Burton, J.D. and Liss, P.S.
5. Chemistry and biogeochemistry of estuaries, 1980 – Olausson, E. and Cato, I.
6. Chemical oceanography (Vol.7), 1978 Riley, J.P. and Chester, R.
7. Waves, tides and shallow-water processes, 1991 – The Open University.
8. Estuarine hydrography and sedimentation, 1986 – Dyer, K.R., John Wiley & Sons.
9. Sea-level rise and coastal subsidence: causes, consequences and strategies, 1966 – Milliman, J.D. and Haq, B.U., Kluwer Academic.
10. The mineral sources of the sea, 1965 – Mcro, J.L.,Elsevier, Amsterdam.

11. Marine minerals: advances in research and resource assessment, 1987 – Teleki, P.G. et al. D. Reidel Dordrechart.
12. Depositional sedimentary environments, 1986- Reinek, H.E. and Singh, I.B., Springer Verlag.
13. Research papers published in scientific journals – last five years.