

**Name Of the Programme: Ph. D. – (Marine Sciences)**

**Title of the Course: Research Methodology**

**Course Code: MSC - 700**

**Number of Credits: 04**

**Effective fom AY: (2022 -23)**

<b>Prerequisites for the Course:</b>	Provisional Ph.D. registration in Marine Sciences.	
<b>Objective:</b>	To impart advanced knowledge on various methods involved in research in Marine Sciences.	
<b>Content:</b>	<b>Module I</b> Measurement of sea surface temperature (CTD), transparency of the ocean, currents in the ocean (ADCP), measurement of air temperature, wind speed and direction, humidity, cloud types and cloud cover, oceanographic moorings, profilers, floats, gliders, psychrometer, anemometer, radio sonde. Matrix algebra– Active and break period analyses of Indian Summer. Standard deviation – covariance – Karl Pearson’s correlation coefficient – hypothesis testing – significance level – t-test – Chi-squared test – Z test – F test – ANOVA.	15 Hours
	<b>Module II</b> General errors in analytical measurements. Validation of analytical data and reference standard materials. Type of water samplers used for analysis of different chemical constituents such as nutrients, trace metals, dissolved gases, major elements in sea water, collection, pretreatment, preservation and analysis. Filtration, characteristics, composition, types of filters and filtration procedure. Instruments used in Chemical Oceanography: their basic principles and instrumentation / methods used for analysis of trace metals, nutrients, pesticides and dissolved gases in sea water.	15 Hours
	<b>Module III</b> Sampling surveys and constraints, long-term cruises and expeditions onboard oceanographic research vessels, small-scale localized surveys on fishing trawlers / port surveys. Equipments and methods for sample collection – water, plankton, benthos, nekton. Benthos – sample preservation, sub-sampling, enumeration and identification. Fish and shellfish – sample preservation, photo-documentation, identification, use of statistical tools for species diversity analysis and influence of environmental parameters, phylogeny and taxonomy.	15 Hours
	<b>Module IV</b> Field survey, sampling and sub-sampling of sediment, equipment and facilities on research vessels, precautions and preservation. Suspended matter, grain size, organic carbon, nitrogen, phosphorus, metals and isotopes analysis. Separation of heavy minerals. Principle and Instrumentation of XRD, XRF, Inductively coupled plasma emission spectrometry. Sediment sample processing for microfossils. Proxies for determination of paleo-productivity.	15 Hours
<b>Pedagogy:</b>	Lectures/ tutorials/assignments/self-study	
<b>References/ Readings</b>	1. von Storch, H. & Zwiers, F. W. (1999). <i>Statistical Analysis in Climate Research</i> . Cambridge, U.K.: Cambridge University Press. 2. Asnani, G. C. (2005). <i>Tropical Meteorology</i> (Revised Edition). Pune, India: G. C. Asnani, Indian Institute of Tropical Meteorology.	

	<ol style="list-style-type: none"> <li>3. Joseph, A. (2014). <i>Measuring Ocean Currents</i>. doi:<a href="https://doi.org/10.1016/C2011-0-05833-7">https://doi.org/10.1016/C2011-0-05833-7</a></li> <li>4. Agarwal, B. L. (2006). <i>Basic Statistics</i>. New Age International Publishers</li> <li>5. Harrison, G. (2015). <i>Meteorological Measurements and Instrumentation</i>. Wiley Blackwell.</li> <li>6. Eleftheriou, A. (2013). <i>Methods for the Study of Marine Benthos</i> (4<sup>th</sup> ed.). Hoboken, New Jersey: John Wiley &amp; Sons, Ltd.</li> <li>7. Goswami, S. C. (2004). <i>Zooplankton methodology, collection and identification- a field manual</i>. National Institute of Oceanography, Dona Paula, Goa.</li> <li>8. Verlecar, X. N. and Desai, S. R. (2004). <i>Phytoplankton Identification Manual</i>. National Institute of Oceanography, Dona Paula, Goa.</li> <li>9. Griffiths, J. C. (1967). <i>Scientific method of analysis of sediments</i>. McGraw-Hill.</li> <li>10. Haq, B. U. and Boersma, A. (1998). <i>Introduction to marine micropaleontology</i>. Elsevier.</li> <li>11. Lindholm, R. (1987). <i>A practical approach to sedimentology</i>. CBS publishers and distributors.</li> <li>12. Loring, D. H. and Rantala, R. T. T. (1992). <i>Manual for geochemical analysis of marine sediments and suspended particulate matter</i>. Earth Science Review.</li> <li>13. Rollinson, H. (2013). <i>Using geochemical data- evaluation, presentation</i>. Interpretation, Routledge.</li> <li>14. Grasshoff K., Kremling K., Ehrhardt M., editors (1999). <i>Methods of Seawater Analysis</i>. (Third edition). Weinheim: Wiley-VCH.</li> <li>15. Ewing, G.W. (1981). <i>Instrumental methods of Chemical analysis</i> (4<sup>th</sup> edition). Mc Graw Hill.</li> <li>16. Hoefs, J. (2004). <i>Stable isotope geochemistry</i> (9<sup>th</sup> edition). Springer International Publishing.</li> <li>17. Groot, P. A. D. (2009). <i>Handbook of Stable isotope analytical techniques Vol. 2</i>. Qxford, UK: Elsevier</li> </ol>	
<b>Course outcomes</b>	The students will be able to conduct sampling and research on various aspects of marine sciences independently.	