	large data sets and generate programs. Plot global ocean /atmosphere data for specific spatial and temporal ranges.	

Programme: M.Sc. (Marine Sciences)
Course Code:MSC 263 **Title of the Course: Law of the Sea and Coastal Regulation Zone**
Number of Credits: 02
Effective from AY: June2018-19

Prerequisites for the course	Students who have undergone courses of semester I of Marine Sciences.	
Objective	This course introduces the law of the Sea and the concept of coastal regulation zone.	
Content	Law of the Sea – Territorial Sea – Contiguous zone – Straits used for international navigation – Archipelagic states – Exclusive economic zone – Continental shelf – High seas – Regime of islands – enclosed or semi-enclosed seas – Right of access of land-locked states – Protection and preservation of marine environment – Scientific and technical assistant – international rules and national legislation to prevent, reduce and control pollution of the marine environment. Coastal Regulation Zone – Demarcation – Prohibited activities – Regulation of permissible activities – Procedure for monitoring and enforcement – Classification of Coastal Regulation Zone – Category I (CRZ-I) – Category II (CRZ-II) – Category III (CRZ-III) – Category IV (CRZ-IV) – Norms for regulation of activities – CRZ-I – CRZ-II – CRZ-III – CRZ-IV – Guidelines for development in the designated areas of CRZ-III – Permitted petroleum products for storage in CRZ.	12 hours 12 hours
Pedagogy	Lectures / Assignments / Seminars / Discussion	
References / Readings	1. United Nations Convention on the Law of the Sea 1982 A Commentary, 2011 volume 7, Nordquist M. N., Martinus Nijhoff Publishers. 2. United Nations Convention on the Law of the Sea, 2009, United Nations, Nova Science Publishers, Inc., New York. 3. Coastal Regulation Zone 2011 and Island Protection Zone 2011 notifications issued 6.1.2011, Ministry of Environment and Forests. 4. Coastal Regulation Zone notification 1991 under E(P)A, 1986 – 19.2.91 5. Coastal Regulation Zone and Island Protection Zone notifications 2011, ICZM project, Ministry of Environment, Forests and Climate change, July 11, 2016.	
Learning Outcomes	1. Understanding of the laws applicable for navigation in sea. 2. Knowledge of international and national legislation to control marine pollution. 3. Understanding coastal regulation zone to prevent the deterioration of coast.	

Programme: M. Sc. (Marine Sciences)
Course Code: MSO 264Title of the Course: Remote sensing and its applications
Number of Credits: 04
Effective from AY: June, 2018-19

Prerequisites for the course:	Students undergoing course in any branch of Marine Sciences.
Objective:	All the coastal process is transient in nature. They are of either diurnal/weekly time scale. To deal with such variability the requirement is a method that would provide a synoptic coverage of the coastal and offshore regions. This is possible only by means of Remote sensing. Hence this emerging technology has been introduced as a course.

Content:	Principles of Electromagnetic radiation– Energy matter interactions –- Rayleigh scattering – Mie scattering – Non selective scattering - Radiative transfer in the atmosphere – Stfan's and Wien's displacement laws –Zenith and azimuth angles. Optical remote sensing – bio-optical properties of sea water - Inherent and apparent optical properties - scattering - absorption-attenuation - diffuse attenuation – Remote sensing reflectance - Case I and Case II waters - radiative transfer in the water column. Sun photometry - Beer-lambert's law - spectral variation of aerosol optical thickness - atmospheric correction - interpretation of ocean colour - spectral response of water as a function of organic and inorganic constituents - Analysis of suspended minerals, chlorophyll *a* and dissolved organic matter through OCM/MODIS data. Thermal infrared remote sensing- Thermal infrared properties - Atmospheric windows - Thermal radiation laws - Emissivity - sea surface temperature retrieval through IR sensors - Active and passive microwave remote sensing - Satellite altimetry of sea surface topography. Sensor characteristics – MSS, GOES, AVHRR, CZCS, SeaWiFS, IKONOS, MODIS, OCM I and OCM - II, LISS -1, LISS-II, WIFS and PAN – Fundamentals of digital image processing – Image rectification – Image enhancement – linear stretching – supervised and unsupervised classification - Introduction to Geographic Information system.	12 hours 12 hours 12 hours 12 hours
Pedagogy:	Being a new and an emerging field, it is necessary to have class room contact hours. Hence, it is a class room taught course. In addition, to get acquaint with the course,seminar topics on the applications of remote sensing are given to the students at the beginning.	
References/ Readings	1. Physical principles of remote sensing, 1990 – Rees, W.G., Cambridge Univ. Press, U.K. 2. Remote sensing optics and optical systems, 1980 – Slater, P.N., Addision Wesley Publ. Co. 3. Remote sensing and image interpretation (2^{nd}edn), 1987 – Lillesand, T.M. and Kiefer, R.W., John Wiley and sons. 4. Remote sensing: Principles and interpretations (2^{nd}edn), 1987 – Floyd and F. Sabnis Jr. W.H. Freeman and Co., New York. 5. Theory and application of optical remote sensing, 1989 – Asrar G., John Wiley & Sons. 6. Introduction to satellite oceanography, 1985 – Maul, G.A., Martinus Nijhoff Publ. 7. Advanced remote sensing from theory to applications (vol.1, 2 & 3), 1981 – Chlamys, F.T., Addision wisley Publ. Co. Inc., Canada. 8. Oceanography from space, 1987- Gover, J.A.R., Plenum Press, New York. 9. Remote sensing of atmospheres and oceans, 1980 - Deepak A., Academic press. 10. Satellite oceanography, 1985 - Robinson, I.S., John Wiley & Sons	
Learning Outcomes	Since the country is in advanced stage in the field of space Technology, the students opting for this course will be trained Manpower to carry forward Nation's need for human resources in the field of Remote sensing.	

Programme: M. Sc. (Marine Sciences)
Course Code: MSO 265 **Title of the Course: Remote Sensing and its applications Practical**
Number of Credits: 02
Effective from AY: June, 2018-19

Prerequisites for the course:	Students undergoing course in any branch of Marine Sciences.
Objective:	This course is the practical component of the theory students learn. This involves satellite data processing for various applications of Ocean/earth/ atmosphere. In this course, students will be exposed to different satellite data, various corrections to be applied and finally image processing for a finished geophysical product.

Content:	**Module - I** 1. Field survey and laboratory analysis to generate apparent optical properties from case II waters using in-water radiometer, and profiles of salinity and temperature using conductivity, temperature and Depth (CTD) sensor, (16 hrs; Ref 1) 2. Generation of Inherent Optical properties (IOP) of optically active substances (OAS), namely absorption of chlorophyll-*a* (Chl-*a*), Chromophoric Dissolved Organic Matter (CDOM) and Total Suspended Inorganic Matter (TSM) from water samples collected during the field survey of case II waters (10 hrs; Ref 1) 3. Simulation of remote sensing reflectance and water leaving radiance from case II waters (4 hrs; Ref 2) **Module – II** 1. Simulation of remote sensing reflectance for each optically active substance and delineation of range of wavelengths susceptible to each OAS and development of empirical algorithms (10 hrs; Ref 3) 2. Generation of aerosol optical depth using sun-photometer and analysis of aerosol optical depth to estimate atmospheric turbidity parameter and Angstrom exponent (8 hrs; Ref 4,5,8) 3. Satellite data processing to map chlorophyll *a*, using ERDAS IMAGINE SeaDAS (12 hrs; Ref 6, 7 and 8)	24 hours 24 hours
Pedagogy:	This course is done through various programming to estimate Parameters followed by usage of different image processing packages. One such package student's use is SeaDAS software.	
References/ Readings	1. Regional validation of MERIS CHLOROPHYLL products in North coastal waters (REVAMP) Protocol, based on NASA and colors protocols, 2002 - Tilstone, G.H, Moore, G.F, Sorensen. K, Doerffer. R, Rottgers, K.G, Ruddick. R, Psterkamp, P.V and Jorgensen, ENVISAT – 1 2. Physical principles of remote sensing, 1990 – Rees, W.G., Cambridge Univ. press, U.K. 25 3. Remote sensing: Principles and interpretations (2^{nd} edn), 1987 – Floyd and F. Sabnis Jr, W.H. Freeman & Co., New York. 4. Theory and applications of optical remote sensing, 1989 – Asrar, G., John Wiley & Sons. 5. Introduction to satellite oceanography, 1985 – Maul, G.A., Martinus Nijhoff Publ. 6. Advanced remote sensing from theory to applications (Vol.1, 2 & 3), 1981, Chlamys, F.T., Addison – Wesley Publ. Co. Inc., Canada. 7. Oceanography from space, 1987 – Grover, J.A.R., Plenum Press, New York. 8. Remote sensing of atmospheres and oceans, 1980 – Deepak, A., Academic Press. 9. SBE plus CTD, User's manual www.seabird.com/pdf_documents/manuals/9_plus_017.pdf 10. Regional Oceanography, an Introduction, 2nd edition, 2003 - Tomczak, Mattias and Stuart Godfrey J, , Daya Publishing house, Delhi.	
Learning Outcomes	Students will be thoroughly trained in different process of satellite Data so as to generate various geophysical products.	

Programme: M. Sc. (Marine Sciences)
Course Code: MSO 266Title of the Course: Analytical Chemistry of Sea water and
Number of Credits: 04 **Instrumental Techniques**
Effective from AY: June, 2018-19

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other University recognized as equivalent.
Objective:	1. The course is aimed at understanding the collection sea water, sediment and biological samples by using different field equipments. 2. To adopt suitable techniques for preservation water, sediment and biological samples for their chemical analyses. 3. The course work is so designed to understand the errors generally occur in the analyses of samples by different techniques. 4. To study different techniques used for extraction of various inorganic chemicals (fresh water, salt, bromine, calcium, magnesium and potassium) and organic chemicals (Agar, Carrageenan and Alginic acid) and 5. To study instruments used (Spectrophotometer, spectrofluorimeter, and flame photometer, AAS, ICP, GC and HPLC) for analyses of different chemical constituents in sea water.