Department of Meteorology and Oceanography

Rokkam Ramanadham Laboratoraries

Andhra University

Visakhapatnam



M. Sc Meteorology and Physical Oceanography Syllabi and Model Question Papers

(Effective from 2021-2022 Academic year)

Program: M.Sc Physical Oceanography

Program Outcomes:

PO1: To train the students in the field of Oceanography and make them equipped with sufficient knowledge to do research on individual basis.

PO2: Basic idea about the physics of oceans and it helps to create new ideas in defense, Fishing, Shipping, Dredging, Tourism Industries and different parts of blue economy.

PO3: Knowledge on different natural hazards, development of new ocean modelling tools, which supports to Shipping industry, Navigation and Disaster Management.

PO4: Expertise in Indian ocean and circulation, its variability and change, and evaluate effectively the importance of tropical ocean-atmosphere coupled processes such as ENSO, IOD to circulation and climate of various regions of the Indian Ocean.

PO5.To impart a strong sense of continuous self-learning and collaborative teamwork

Program Educational Outcomes:

PEO1: To provide quality post–graduation education in Oceanography and to prepare students for entering teaching in Universities, PhD/research programs within India (National laboratories or in R&D wings of various industries/university laboratories) or abroad.

PEO2: To pursue jobs in earth sciences, atmospheric sciences and oceanography laboratories, universities, NIT's, IITs among other related fields.

PEO3: To equip students with the knowledge and ability to solve Oceanography problems of social relevance and to know the importance of weather in the real-time prediction like Cyclones, monsoons, RIP currents, Sea state.

PEO4: To apply their Oceanography skill set in regulating coastal erosions, coastal processes, prediction of micro, macro and synoptic scale to large scale systems with latest numerical models and coupled models

PEO5: The skilled professionals develop and apply critical and analytical thinking to address scientific challenges in CRZ, Blue economy, Coastal security.

Program Learning Outcomes

PLO1: Student will learn how to design instruments for ocean observations, to develop ocean models to estimate the state of the ocean and apply knowledge of Ocean to various allied fields.

PLO2: Acquire fundamental and coherent scientific knowledge of the coastal, estuarine system and its interactive components,

PLO3: Utilize the state-of-the-art scientific and technical knowledge, and tools such as Acoustic tomography and SONARS, and ocean bottom imaging data to analyze and interpret ocean vertical structure (Temperature and salinity) and ocean biological processes.

PLO4: Provide practical knowledge on collecting ocean and atmospheric observations, carrying out calculation, and analyzing various parameters for understanding the physics and dynamics of oceans.

PLO5: Demonstrate the ability to identify, construct, and analyze the interactions between oceanographic processes through a range of spatial and temporal scales.

Approved Course Pattern and Syllabi w.e.f. 2020-2021 academic year M.Sc. (Physical Oceanography)

Course No.	Title of the Paper	Internal assessment marks	Semester end examination marks	Total Marks	Credits
Theory:					
PO-101	Physics and Dynamics of Climate	20	80	100	4
PO-102	Physical Meteorology	20	80	100	4
PO-103	Dynamics of the Atmosphere	20	80	100	4
PO-104	Physical Oceanography	20	80	100	4
Practicals:					
PO-105	Meteorology Computations	20	80	100	4

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PO-407 Use of Satellite data in Meteorology &
Oceanography (MOOC II) 100 2
PO-408 Value added course (Research
Methodology) 100 2
Total 120 530 850 30
Grand Total $(1+2+3+4 \text{ semesters})$ 480 2120 3000 112

M.Sc. Physical Oceanography

First Semester

<u>PO – 101: Physics and Dynamics of Climate</u>

[Common Syllabus with M.Sc. (Meteorology) First Semester]

PO-102: Physical Meteorology

[Common Syllabus with M.Sc. (Meteorology) Second Semester]

<u>PO – 103: Dynamical of the Atmosphere</u>

[Common Syllabus with M.Sc. (Meteorology) First Semester]

<u>PO – 104: Physical Oceanography</u>

[Common Syllabus with M.Sc. (Meteorology) First Semester]

PO – 105: Meteorology computations

[Same as M.Sc. (Meteorology) First Semester]

PO-106: FORTRAN Programming (Practical)

[Common Syllabus with M.Sc. (Meteorology) Second Semester]

Second Semester

PO-201: Dynamical Oceanography

[Common Syllabus with M.Sc. (Meteorology) Second Semester]

<u>PO – 202: Geophysical Fluid Dynamics</u>

[Same as M.Sc. (Meteorology) First Semester]

PO – 203: Meteorology and Oceanography Instruments

[Same as M.Sc. (Meteorology) First Semester]

PO-204: Synoptic Meteorology

[Common Syllabus with M.Sc. (Meteorology) Second Semester]

PO-205: Ocean Computations(Practical)

PO – 206: Observation Techniques (Practical)

[Same as M.Sc. (Meteorology) First Semester] [Common Syllabus with M.Sc. (Meteorology) Second Semester]

Third Semester

<u>PO-301: Numerical Weather Prediction</u> [Common Syllabus with M.Sc. (Meteorology) Third Semester]

PO-302: Air Sea Interaction [Common Syllabus with M.Sc. (Meteorology) Third Semester]

<u>PO-306: Synoptic Analysis(Practical)</u> [Common Syllabus with M.Sc. (Meteorology) Third Semester]

Fourth Semester

PO-401: Climate and Ocean Modelling [Common Syllabus with M.Sc. (Meteorology) Third Semester]

PO-402: Satellite Meteorology and Satellite Oceanography [Common Syllabus with M.Sc. (Meteorology) Second Semester]

M.Sc. Physical Oceanography PO-303: Indian Ocean Dynamics

Unit-I

Physical characteristics of the Indian Ocean – size, shape, ocean basin, mid oceanic ridge system, ocean floor and seas.

Physical, dynamical and biological characteristics of the Arabian Sea, Bay of Bengal and Equatorial Indian Ocean

Physio – Chemical and marine ecosystem of the Andaman Sea and Lakshadweep sea.

Unit- II

Surface forcing – winds, radiation, river discharge, Ekman spiral/transport, Geostrophic currents, meanders and rings, Warm pool, Langmuir cells/circulation. Regions of upwelling and sinking along Indian Ocean.

Surface circulation- Gyre systems along north and south Indian Ocean

Unit-III

Indian Ocean currents - SW & NE monsoon drift (Indian monsoon current), Somali Current, Equatorial counter current, Indonesian through flow, south equatorial current, East Madagascar current, Mozambique current, Agulhas current, Leeuwin current, west Australian current, south Australian counter current, west wind drift.

Unit-IV

Indian Ocean cross-equatorial flow, meridional overturning, Conveyor belt, subtropical gyres. Variability of Indian Ocean currents – monsoon circulation, Great Whirl, circulation pattern during the events of ENSO and IOD, Equatorial Indian Ocean – Wyrtki jet, Indian Ocean Dipole.

Unit-V

Thermohaline circulation - Thermal structure of Indian Ocean, variability of Mixed Layer and Barrier Layer, thermocline, salinity fluctuations, water mass characteristics of Indian Ocean, under currents and thermohaline circulation.

Text books

- 1. Ocean Circulation Prepared by open university course team
- 2. The Indian Ocean : A Perspective by Rabin Sen Gupta, Ehrlich Desa
- 3. Ocean circulation and climate Observing and modeling the global ocean Gerold Siedler, John Church, John Gould.
- 4. Ocean and Climate Grant R. Bigg

Indian Ocean Dynamics:

Dr. T.V. Ramanamurty	Dr. Harilal B Menon	
Di. 1. V. Kalilananarty	Associate Drofessor	
Scientist	Associate Professor	
NIO, Visakhapatnam	Dept. of Marine Sciences	
Ph: 0891-2539180 Fax: 2543595	Goa University, Taleigao Plateau	
Email: <u>tvrmurty@nio.org</u>	Goa- 403206, India	
	Email: <u>hbmenon@unigoa.ac.in</u>	
Dr. Y. Sadhuram	Prof. P.K. Bhaskaran	
Emeritus Scientist	Professor	
National Institute of Oceanography (NIO)	Oceans Engineering & Naval Architecture	
Visakhapatnam. Email:	Indian Institute of Technology Kharagpur	
sadhuram@nio.org	Kharagpur – 721302, INDIA	
Ph: 0891-2539180 Fax: 2543595	Email: <u>pkbhaskaran@noval.iitkgp.ernet.in</u>	
Dr. A Suryachandra rao	Dr. R.R. Rao	
Scientist E	Dept. of Meteorology and Oceanography	
Indian Institute of Tropical Meteorology	Andhra University, Visakhapatnam	
Dr. Homibaba Road, Pashan	Email: <u>rokkamrr@yahoo.com</u>	
Pune-411008, Maharashtra, India	Ph:9701053274	
Email: <u>surya@tropmet.res.in</u>		
Prof. A.D. Rao		
Professor		
Center for Atmospheric Sciences		
Indian Institute of Technology Delhi		
Hauz Khas, New Delhi – 110016, India		
Email: adrao@cas.iitd.ac.in		

M.Sc. Physical Oceanography PO-304: Coastal and Estuarine Process

Unit I:

Coastal Process, Coastal classification, Morpho dynamic approaches and behavior to coastal systems, long-term changes. Coastal sand dunes, coasts and climate. Submerged aquatic vegetation-seagrasses. Coastal and near shore circulation-long shore currents.

Unit II:

Sea level changes : Periodic sea level changes – short term variations – long term changes – Impact of global warming on sea level – impacts of sea level rise.

Unit III:

Beach features: Beach cycles, beach profiles-erosion and accretion, Sediment transport rate – onshore and offshore transport – coastal features – LEO observation beach stability – artificial nourishment – coastal defence structures – planning and design of coastal structures – tidal inlets and Lakes, deltas. Minerals of the deep seabed -Technology and economics. Indian Deep Sea mining program

Unit IV:

Estuaries: Classification, tides in estuaries, estuarine circulation and mixing, Hydrology and hydrograph, sedimentation in estuaries. Estuarine Habitats, Natural, Human Disturbances and monitoring the estuaries

Unit V:

Salinity intrusion in estuaries, effect of stratification, coastal pollution: mixing and diffusion dispersal of pollutants in estuaries, tidal prism concept. Geo-spatial technology, lake dynamics (chilika, kolleru, and pulicat). Coastal pollution - Black tide, HAB, oxygen depletion in coastal waters, Mixing and dispersal of pollutants in estuaries.

Reference books:

- 1. Coastal and Estuarine Dynamics by A.T. Ippen
- 2. Estuaries: A Physical Introduction by K.R. Dyer
- 3. Coastal Engineering by Kiyoshi Horikawa

Coastal and Estuarine Processes:

Dr. Y. Sadhuram	Dr. T.V. Ramanamurty
Emeritus Scientist	Scientist
National Institute of Oceanography (NIO)	NIO, Visakhapatnam
Visakhapatnam. Email: <u>sadhuram@nio.org</u>	Ph: 0891-2539180 Fax: 2543595
Ph: 0891-2539180 Fax: 2543595	Email: <u>tvrmurty@nio.org</u>
Prof. K.P.R. Vittal Murthy	Dr. Y. Sadhuram
Retd. Professor	Emeritus Scientist
Dept. of Meteorology and Oceanography	National Institute of Oceanography (NIO)
Andhra University, Visakhapatnam.	Visakhapatnam. Email: sadhuram@nio.org
Email: kolavennup@gmail.com Ph: 0891-	Ph: 0891-2539180 Fax: 2543595
<u>2530289</u>	
Dr. V.S.N. Murthy	Prof. A.D. Rao
Director I/C	Professor
Scientist G,	Center for Atmospheric Sciences
National Institute of Oceanography (NIO)	Indian Institute of Technology Delhi
Visakhapatnam. Email: <u>vsnmurty@nio.org</u>	Hauz Khas, New Delhi – 110016, India
Ph:0891-2539180, Fax:2543595	Email: adrao@cas.iitd.ac.in
Dr. P. Vethamony	Dr. V. Sanil Kumar
Retd. Chief Scientist,	Senior Principal Scientist
Adjunct Professor in IIT Bombay	NIO, GOA
Ph: 919422845270	Email: <u>sanil@nio.org</u>
Email: vethamony@gmail.com	
NIO, GOA	
Dr D. Jyothi	
President (Environment), Gangavaram Post	
Pedagantyada, Visakhapatnam-530044.	

PO-305: Physical Oceanography Practicals

- 1. Wave Data Analysis Rose Diagrams
- 2. Wave Refraction Diagrams
- 3. Computation of Longshore currents
- 4. Computation of relative currents.
- 5. Beach Profiles and slope estimation
- 6. Estimation of MLD and BLT from T/S profiles
- 7. Argo data analysis.
- 8. Tidal analysis a) calculation of Form number, b) tidal interpolation and c) datum correction
- 9. Identifying ENSO and IOD years by computing the respective indices using long term SST data.
- 10. Identifying the dominant modes of short-term climate variability (El Nino in the Indo-Pacific region and IOD patterns in the Indian Ocean) using EOF technique.
- 11. Scaling of Eqaution
- 12. Compute Rossby Number, Fraud Number etc.

M.Sc. Physical Oceanography PO-403 : Coastal Zone Management and Ocean Resources

Unit-I

Coastal zone management: Classification of Coastal Regulatory Zone (CRZ), Genesis of CRZ and its importance. Integrated CZM program and its development. Management of Dune, Mangrove forest, urban runoff and seawage. Tourism Management- Marine and coastal recreation. GIS applications in CZM.

Unit-II

Coastal zone management: Laws relevant for coastal zone management, prohibited activities, relevant legislations, Coastal security, Tidal flats, deltas, Maintenance of Aquaculture farms

Unit-III

Ocean resources: Transportation and Shipping, minerals, water, fuels, Potential fishing zones (PFZ), Gas hydrates, Harnessing of the Ocean. Energy Resource: Ocean Thermal Energy Conversion (OTEC) plants, wave energy and tidal energy. Minerals of the deep seabed - Technology and economics. Indian Deep Sea mining program

Unit-IV

Coastal Hazards: dynamics of rip current, forecasting, tsunamis, storm surge, oil spills and disaster management. Coastal Erosion Mitigation, Coastal Flooding Mitigation. Management of coastal erosion and flooding under climate change.

Unit-V

Coastal constructions: Jetties, groins, Piers, breakwaters, maintenance of entrance channels, safety measures for coastal areas. Hard, soft, store and retreat strategies to protect the coast.

Text books

- 1. An Introduction to Coastal Zone Management by Timothy Beatley, David Brower, Anna K. Schwab
- 2. The Coast: Hazardous Interactions within the Coastal Environment by Timothy M. Kusky
- 3. GIS for Coastal Zone Management by Darius J Bartlett, Jennifer L Smith
- 4. Coastal Zone Management Imperative for Maritime Devloping Nations by Bilal U Haq, Gunnar Kullenberg
- 5. Coastal zone management handbook by John R. Clark

Coastal Zone Management and Ocean Resources:

Prof. K. Gopala Reddy	Dr. Rashmi Sharma	
Retd. Professor	Oceanic Sciences Division	
Department of	Meteorology and Oceanography Group	
Meteorology&Oceanography	Space Application Centre	
Center for Studies on Bay of Bengal	Ahmedabad – 380015	
Andhra University, Visakhapatnam-03	Email: rashmi@sac.isro.gov.in	
Ph:9989191239 Email:		
kgreddy_52@yahoo.co.in		
Dr. Y. Sadhuram	Dr. V.S.N. Murthy	
Emeritus Scientist	Director I/C	
National Institute of Oceanography (NIO)	Scientist G,	
Visakhapatnam. Email: <u>sadhuram@nio.org</u>	National Institute of Oceanography (NIO)	
Ph: 0891-2539180 Fax: 2543595	Visakhapatnam. Email: <u>vsnmurty@nio.org</u>	
	Ph:0891-2539180, Fax:2543595	
Dr. T.V. Ramanamurty	Dr. R.R. Rao	
Scientist	Dept. of Meteorology and Oceanography	
NIO, Visakhapatnam	Andhra University, Visakhapatnam	
Ph: 0891-2539180 Fax: 2543595	Email: <u>rokkamrr@yahoo.com</u>	
Email: <u>tvrmurty@nio.org</u>	Ph:9701053274	

M.Sc. Physical Oceanography PO-404: Acoustical Oceanography

Unit-I:

Physical and biological characteristics of sea: Ocean stratification, sound speed and Ray refraction: Fundamentals of acoustics: A review of basic vibration theory, basic acoustic theory, and the physics of sound propagation, reflection, and absorption phenomena.

Unit –II:

Physical characteristics of the sea related to sound transmission. Internal waves. Types of sound losses – Cylindrical, Spherical and Tramission Loss. Sound velocity vertical structure of the sea. Concepts of absorption, scattering, attenuation, heat conduction, reflection and refraction of sound propagation in the sea. Temperature, salinity and depth effects on sound propagation, SOFAR channel.

Unit III:

Acoustic Wave Equation – Normal mode theory and Ray theory, GM theory. Transmission of sound in shallow waters and its applications. Transmission of sound in deep waters and its applications.

Unit-IV:

Sonar Concepts Overview: overview of the active and passive sonar equations. components in sonar equations in terms of the relevant physics and system parameters. Doppler effect; Different types of Sonars. Propagation and Scattering in Shallow Water: Ocean bottom imaging. Pollution monitoring.

Unit-V:

Bioacoustics: Role of active and passive acoustic technology in studying organisms in the marine environment. Sensing of plankton and nekton; passive acoustics: rainfall at sea and marine animals, marine mammals. Acoustic tomography, time reversal and turbulence.

Reference books:

- 1. Fundamentals of Marine Acoustics Jerald W.Caruthers, 1977
- 2. Introduction to the theory of sound transmission with Application to Ocean C.B.Officer, 1958
- 3. An introduction to underwater acoustics, Xavier Lurton, 2002

Acoustical Oceanography:

Dr TV Ramanamurty	Dr. Rashmi Sharma	
Scientist	Oceanic Sciences Division	
NIO Visakhanatnam	Meteorology and Oceanography Group	
Ph. 0801 2530180 Eax: 25/3505	Space Application Centra	
Emeil: turmutu@nio.org	Abmadahad 280015	
Eman. tvrmurty@mo.org	Anniedadau – 560015	
	Email: <u>rashmi@sac.isro.gov.in</u>	
Dr. P. Vethamony	Dr. V. Sanil Kumar	
Retd. Chief Scientist,	Senior Principal Scientist	
Adjunct Professor in IIT Bombay	NIO, GOA	
Ph: 919422845270	Email: <u>sanil@nio.org</u>	
Email: vethamony@gmail.com		
NIO, GOA		
Dr. Y. Sadhuram	Dr. V.S.N. Murthy	
Emeritus Scientist	Director I/C	
National Institute of Oceanography (NIO)	Scientist G,	
Visakhapatnam. Email: <u>sadhuram@nio.org</u>	National Institute of Oceanography (NIO)	
Ph: 0891-2539180 Fax: 2543595	Visakhapatnam. Email: <u>vsnmurty@nio.org</u>	
	Ph:0891-2539180, Fax:2543595	
Prof. K. Gopala Reddy	Dr. R.R. Rao	
Retd. Professor	Dept. of Meteorology and Oceanography	
Department of	Andhra University, Visakhapatnam	
Meteorology&Oceanography	Email: <u>rokkamrr@yahoo.com</u>	
Center for Studies on Bay of Bengal	Ph:9701053274	
Andhra University, Visakhapatnam-03		
Ph:9989191239 Email:		
kgreddy 52@yahoo.co.in		

Model question Paper MSc. Meteorology /Physical Ocenography

Time: 3 hrs.

Max.Marks: 80

Answer all questions All question carry equal Marks 5×16=80 1) a) Unit I OR b) Unit I 2) a) Unit II OR b) Unit II 3) a) Unit III OR b) Unit III 4) a) Unit IV OR b) Unit IV 5) a) Unit V

OR b) Unit V