



**Shri Vile Parle Kelavani Mandal's
MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE &
AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS
(AUTONOMOUS)**

*NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),
Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India
Best College (2016-17), University of Mumbai*

Affiliated to the
UNIVERSITY OF MUMBAI

Program: Master of Science

Subject: Zoology

Semester: III & IV

Choice Based Credit System (CBCS) with effect from the Academic year 2022-23

A.C. No: 13

Agenda No: 3 (Xvii)

Sw. 14

1/2

H. Talpade

1/2

R.S.

1/2

V. N. Shingale

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

PSO-1 On completion of the M.Sc.- Zoology (Oceanography), the learners should be enriched with knowledge and be able to acquire information on the various aspects of Zoology including Developmental Biology, Evolution, Human Genetics, Animal Biotechnology in relation to human therapies.

PSO-2 On completion of the M.Sc. - Zoology (Oceanography), the learners should be enriched with knowledge and be able to understand taxonomical aspects of invertebrates, minor phyla, protochordates and vertebrates.

PSO-3 On completion of the M.Sc. - Zoology (Oceanography), the learners should be enriched with knowledge and be able to grow interest in study of Human evolutionary history and Tree of life.

PSO-4 On completion of the M.Sc. - Zoology (Oceanography), the learners should be enriched with knowledge and be able to enhance skills for analytical techniques like microscopy, spectroscopy, chromatography and imaging techniques.

PSO-5 On completion of the M.Sc.- Zoology (Oceanography), the learners should be enriched with knowledge and be able to develop research aptitude with experimental exposure to applications of model organisms to have in-depth understanding of avenues of developmental biology and Genetics with emphasis to generate interest towards research & development.

PSO-6 On completion of the M.Sc. - Zoology (Oceanography), the learners should be enriched with knowledge and be able to develop research-based thinking and learning with remodeling of career in research fields with emphasis on application-based research.

PSO-7 On completion of the M.Sc. - Zoology (Oceanography), the learners should be enriched with knowledge and be able to identify various statistical tools for research in biosciences & have complete know how of its use with elaborate applications.

PSO-8 On completion of the M.Sc.- Zoology (Oceanography), the learners should be enriched with knowledge and be able to acquire information on various domains of oceanography including physical oceanography, Chemical oceanography, oceanic resources, biology of the ocean, fish & fisheries.

Preamble

While presenting this new syllabus under the autonomous status of the college of Semester III and Semester IV (M.Sc.) Zoology, efforts have been made to seek inputs of all the stake holders to make it relevant, useful to learners.

In the meeting of the subject experts, inputs were obtained from the experts of various fields of zoology such as eminent scientists, academicians and ex-students. Efforts have been taken to introduce relevant topics so that students get stimulated to the recent approaches and vivid aspects in oceanography, research aptitude enhancing their employability.

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

With co-operation of teachers and participation of students the syllabus would generate interest in the mind of learners about the subject and equip them with the enhanced knowledge bridging the gap between industry and academia.

The courses are as follows: -

Semester III:	PSMAZOOOCN305	General and Physical Oceanography
	PSMAZOOOCN306	Chemical Oceanography
	PSMAZOOOCN307	Biology of the ocean-I
	PSMAZOOOCN308	Fisheries – I
	PSMAZOOOCNP35	Oceanography Practical I
	PSMAZOOOCNP36	Oceanography Practical II
	PSMAZOOOCNP37	Oceanography Practical III
	PSMAZOOOCNP38	Oceanography Practical IV
Semester IV:	PSMAZOOOCN405	Marine Water Dynamics and Geology
	PSMAZOOOCN406	Oceanic Resources
	PSMAZOOOCN407	Biology of the ocean-II
	PSMAZOOOCN408	Fisheries -II
	PSMAZOOOCNP43	Oceanography Practical I
	PSMAZOOOCNP44	Oceanography Practical II
	PSMAZOOOCNP47	Oceanography Practical III
	PSMAZOOOCNP48	Oceanography Practical IV

I profusely thank all the committee members for their efforts in drafting the syllabus.

N.B. - (i) The duration of each theory lecture will be of 60 minutes. A course consists of 4 units. For each unit the number of hours allotted are 15. The total number of lecture hours for each course will thus be 60.

(ii) There will be one practical per batch for each course. The duration of each practical will be of 4 hours, i.e. of 240 minutes.

(iii) Thus in a week, a student will study 4 hours of theory and 4 hours of practical per course.

Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Presentation	15 marks
Component 2 (CA-2)	MCQ Test	10 marks

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**


Program: Master of Science (Zoology)				Semester: III	
Course: General and Physical Oceanography				Course Code: PSMAZOO CN305	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • Learners would be able to understand different changes occurring with earth leading to the formation of oceans and seas as well as specific physical properties of the oceans. • Learners would explore the findings of various expeditions of oceans with special reference to Indian Ocean to make them think about the possibilities related to Blue Economy and conserving marine ecosystem. 					
Course Outcomes:					
After completion of the course, learners would be able to:					
CO1: compare all changes which occurred with earth's crust that led to the formation of oceans and seas.					
CO2: examine specific physical properties of the oceans to relate their importance.					
CO3: assess the findings of various expeditions of Indian Ocean to estimate the possibilities of their utility with Blue Economy.					
CO4: design mechanism using artificial intelligence for exploration and conservation of marine ecosystem.					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Evolution of oceans				15
2	General Oceanography				15
3	Physical Oceanography				15
4	Expeditions				15
	Total				60
	PRACTICALS				60

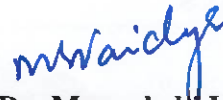
**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**


b) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description (Offline mode)	Marks	Total Marks
1.	a) Two questions of 10 marks from Module I (any One) b) One question of 05 marks from Module I (Compulsory)	10 05	15
2.	a) Two questions of 10 marks from Module II (any One) b) One question of 05 marks from Module II (Compulsory)	10 05	15
3.	a) Two questions of 10 marks from Module III (any One) b) One question of 05 marks from Module III (Compulsory)	10 05	15
4.	a) Two questions of 10 marks from Module IV (any One) b) One question of 05 marks from Module IV (Compulsory)	10 05	15
5.	One question from each Module (any THREE)	05	15
Total Marks			75


Dr. Meghana Talpade
HOD


Dr. Meenakshi Vaidya
Approved by Vice –Principal


Dr. Krutika Desai
Approved by I/c Principal

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Module	General and Physical Oceanography	No. of Hours/Credits 60/4
1	Evolution of oceans	15
	Introduction to planet Earth: The principal oceans of the world, Oceans versus Seas, Birth and growth of oceans Origin of land and oceans: *Evidence of Continental Drift and Plate Tectonics	5
	Theories of the origin of ocean basin: Nebular hypothesis, Planetesimal hypothesis, Continental Drift hypothesis (Taylor's Theory), Displacement hypothesis (Wegener's theory)	5
	Sea floor spreading and features of ocean basins Plate boundaries – Features of Convergent, Divergent and Transform boundaries	4
	*Formation and distribution of sea ice and icebergs	1
2	General Oceanography	15
	History and Birth of Oceanography	1
	The ocean floor: *Continental Margins-Continental Shelf, Continental, Slope & Continental Rise, Deep-ocean Basins- Abyssal plain, Volcanic peaks, Ocean trenches & Volcanic arcs, Submarine mountain ranges - Mid-ocean ridge and Guyots, Hydrothermal vents	6
	Submarine canyons and troughs: Types, distribution, and location of glacial and non-glacial canyons, Submarine canyons in the Atlantic, Pacific and Indian Ocean	5
	*Ocean research laboratories and observatories across the world	3
3	Physical Oceanography	15
	Physical properties of sea water: Thermal properties of water - Temperature, heat and potential temperature, *Pressure, density, compressibility, viscosity, water masses and its distribution	3
	Artificial Intelligence in Oceanography- Sensor equipped drones and Robots collect data such as pH, Salinity, Turbidity, pollutants	
	Optical properties of sea water: Transparency and light penetration	
	Temperature: Source of heat and insolation on oceans, Process of heating and cooling of oceans, Heat budget of the oceans, Horizontal and vertical distribution of temperature on oceans, Temperature Changes in the sea, influence of temperature on the reactions of fish, spawning, feeding, metabolism & growth and abundance, migrations & shoaling of the fish and mortality of the fish populations.	2
	Density: Horizontal and vertical distribution of density,	4
		3

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	*Factors controlling density of oceans, Effect of temperature and salinity on density, Effect of pressure on density, Variation of density-Thermocline, halocline and pycnocline, Freezing point of sea water	1
	Compressibility: Effect of temperature and salinity on compressibility	2
	Light- Absorption of light in sea water, Effects of light on spawning and survival of fish larvae, Diurnal Vertical Migrations	
4	Expeditions	15
	Ancient apparatus: expedition- The early history of Diving – Halley's diving bell, History of Scuba Design, Armoured diving suit, Scuba ring, The Fleuss apparatus (Closed circuit oxygen rebreather)	7
	*The HMS Challenger Expedition	2
	*International India Ocean Expedition	2
	Antarctic Ocean Expedition	2

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Oceanography Practical I PSMAZOO CNP35		Credits- 02
Based on General and Physical Oceanography PSMAZOO CN305		
Sr. No.	Topic.	
1	Selection of Research area/Topic/ project work and referencing.	
2	Framing of Research problem.	
3	Preparation of Research Proposal or Synopsis.	
4	Literature review	
5	In-plant training/internship (minimum of one week duration): Students are supposed to submit in-plant training report and certificate of completion	
6	Pilot study of proposed research work/project work	

RECOMMENDED READING:

Essential Reading:

- The oceans - Their Physics, Chemistry and General Biology, The oceans - Their Physics, Chemistry and General Biology, Sverdrup, H. U., M. W. Johnson and R. H. Fleming, 1942, Asia Publishing House
- Essentials of Oceanography, Trujillo, A. P. and H. V. Thurman, Tenth Edition, PHI Learning Private Limited (Indian Edition)
- Introduction to the Physical and Biological Oceanography of Shelf Seas, Simpson J. H. and J. Sharples, First Edition 2012, Cambridge University Press
- Ross, David A., Introduction to Oceanography, 1977, Second Edition, Prentice-Hall
- A textbook of Marine Ecology, Nair, B. N. and D. M. Thampy, First Edition 1980, The Macmillan Company of India Limited
- Elements of Marine Ecology, Tait, R. V and F. A. Dipper, Fourth Edition, Butterworth-Heinemann A division of Reed Educational and Professional Publishing Ltd.

Supplementary Readings:

- Oceanography - The Last Frontier, Vetter R. C., First Edition 1974, Voice of America Forum Series
- Oceanography - Contemporary Readings in Ocean Sciences, Pirie, R. G., 1977. Second Edition, Oxford University Press Inc.
- Oceanography for Geographers, Sharma, R. C. and M. Vatal, 1995, Fifth Edition, Chaitanya Publishing House
- Glimpses of The Indian Ocean, Qasim, S.Z., 1998, First Edition, Sangam Books Ltd.
- The Sea Floor - An Introduction to Marine Geology, Seibold, Eugen, Berger, Wolfgang H., 4th Edition 2017, Springer International Publishing

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

- An Introduction to Marine Geology, Keen, Michael John & M. J. Keen, First Edition 1968, Pergamon Press
- Introduction to Physical Oceanography, Knauss John A. and Newell Garfield, First Edition 2016, Waveland Press
- Descriptive Physical Oceanography – An introduction, Talley, Lynne D., Pickard, Emery and Swift, 6th Edition 2011, Elsevier Publisher

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Program: Master of Science (Zoology)				Semester: IV	
Course: Marine water dynamics and Geology				Course Code: PSMAZOOCN405	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • To make learners understand the phenomena like waves, current, tides and their effects leading to Tsunami and cyclones. • To introduce learners with oceanographic instruments, marine geological knowledge for its possible exploration which is the most recent topic of oceanography. 					
Course Outcomes:					
After completion of the course, learners would be able to:					
CO1: differentiate significance of oceanographic instruments, their utility and their upgradation with changing need. CO2: summarize meaning, cause, utility and impact of wave, tide, current, cyclone etc. CO3: measure the importance of marine geology vis-a-vis the wealth of Ocean and seas and its significance to the mankind.					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Oceanographic Instrumentation				15
2	Waves, Tides and Currents				15
3	Cyclones and Tsunamis				15
4	Marine Geology				15
	Total				60
PRACTICALS					60

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Module	Marine water dynamics and Geology	No. of Hours/Credits 60/4
1	Oceanographic Instrumentation	15
	Measurement of seawater properties: Temperature - Reversing thermometer and Bathythermograph, CTD – Scanfish, pH- pH meter, Current -Current meter, Electromagnetic flow meter, Pressure - Submersibles, A scuba diver's submersible pressure gauge (SPG) or depth Gauge, Pressure sensors	5
	Acoustic devices - Acoustic Doppler current profiler (ADCP, or ADP, Acoustic Doppler profiler), Hydrophones, Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs), Unmanned Underwater Vehicles (UUVs)	4
	Water sampling devices: Study of physico-chemical properties - Reversing Nansen bottles, Niskin sampler, Study of Plankton - Plankton nets: Standard net, Hensen Net, Clarke, Bumpus Net	4
	*Sediment sampling devices: Grab (Peterson and Van veen), Corer, Dredge	
	*Satellite Remote Sensing and SONAR in ocean exploration, Underwater Photography	2
	Oceanographic vessels used in India- RV Sindhu Sankalp, RV Sindhu Sadhana	
2	Waves, Tides and Currents	15
	Vertical circulation: Wind induced circulation, Thermohaline circulation	2
	Waves: Causes of waves, *Nature and Characteristics of waves- Shallow water waves, Deep water waves, Transitional waves, *Wind generated waves, Destructive waves	4
	Tides: Tide generating forces, Theories of tides, Types of tides, Tide tables and tidal predictions, *Tide as a source of power	3
	Currents: Origin of surface currents, Factors controlling ocean currents - Ekman Spiral, Upwelling and Down welling, Indian Ocean circulation and Pacific Ocean circulation	2
		4
3	Cyclones and Tsunamis	15
	Air-Sea interaction: Coriolis Effect, Changes in the Coriolis Effect with latitude	2
	*El Niño and La Niña- Causes and effects	2
	Seismic waves - earthquakes, volcanic islands	1
	Four categories of Tropical cyclones - Tropical depression (TD), Tropical storm (TS), Typhoon (TY) and super typhoon	3
	*Tropical cyclones - hurricanes and typhoon	
	Tornadoes, Mesocyclones, Mid-tropical/extra tropical cyclones, Polar LOEs and arctic Hurricanes	3
	Tsunamis -Causes and effects	2
	Warning systems for oceanic natural disasters	2

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

4	Marine Geology	15
	*Scientific and economical aspect of seabed exploration and mining	1
	Geophysical importance and nature of the sediments on the continental shelf	2
	Sources and nature of oceanic deposits: Terrigenous and Pelagic deposits, material, Products of volcanism, Extra-terrestrial matter.	6
	Geophysical studies using gravity, magnetic and seismic exploration techniques in Arabian Sea and Bay of Bengal	3
	*Sea floor mapping	1
	Seismic reflection Profiles and Subsurface geology.	2

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Oceanography Practical I PSMAZOO CNP43		Credits- 02
Based on Marine water dynamics and Geology, PSMAZOO CN405		
Sr. No.	Topic	
1	Practical/ Field work related to Research proposal / Synopsis/ Project.	
2	Preparation of a research paper based on findings or a result of pilot work /field work/experiment.	
3	Compilation of data, findings, their analysis and conclusion.	
4	Preparation of final synopsis /research paper/report of project	
5	Publication of Research paper in UGC CARE List/ Peer Reviewed Indexed journals.	
6	Presentation/ Submission of the Research Project.	

RECOMMENDED READING:

Essential Reading:

- The oceans - Their Physics, Chemistry and General Biology, Sverdrup, H. U., M. W. Johnson and R. H. Fleming, 1942, Asia Publishing House
- Essentials of Oceanography, Trujillo, A. P. and H. V. Thurman, Tenth Edition, PHI Learning Private Limited (Indian Edition)
- Introduction to the Physical and Biological Oceanography of Shelf Seas, Simpson J. H. and J. Sharples, First Edition 2012, Cambridge University Press
- Oceanography - Contemporary Readings in Ocean Sciences, Pirie, R. G., 1977. Second Edition, Oxford University Press Inc.
- A textbook of Marine Ecology, Nair, B. N. and D. M. Thampy, First Edition 1980, The Macmillan Company of India Limited
- An Introduction to Marine Geology, Keen, Michael John & M. J. Keen, First Edition 1968, Pergamon Press

Supplementary Readings:

- Oceanography - The Last Frontier, Vetter R. C., First Edition 1974, Voice of America Forum Series
- Glimpses of The Indian Ocean, Qasim, S.Z., 1998, First Edition, Sangam Books Ltd.
- Introduction to Oceanography, Ross, David A., 1977, Second Edition, Prentice-Hall
- The Seas, Russell & Yonge, Second Edition 1958, Frederick Warne & Co. Ltd.
- Elements of Marine Ecology, Tait, R. V and F. A. Dipper, Fourth Edition, Butterworth- A division of Reed Educational and Professional Publishing Ltd.
- Research methods in Marine Biology, Heinemann Schlieper, Carl, First Edition 1972, Sidgwick & Jackson Ltd.

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

- Introduction to Physical Oceanography, Knauss John A. and Newell Garfield, First Edition 2016, Waveland Press
- Descriptive Physical Oceanography – An introduction, Talley, Lynne D., Pickard, Emery and Swift, 6th Edition 2011, Elsevier Publisher
- The Sea Floor - An Introduction to Marine Geology, Seibold, Eugen, Berger, Wolfgang H., 4th Edition 2017, Springer International Publishing

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Program: Master of Science (Zoology)				Semester: III	
Course: Chemical Oceanography				Course Code: PSMAZOO CN306	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • To study the physiography of oceans, acquire knowledge of various oceanographic institutes and marine chemistry. • To study the Paleo-oceanography & Sedimentology and its ecosystems including climatic change. 					
Course Outcomes:					
After completion of the course, learners would be able to:					
CO1: estimate the physical and chemical properties of seawater.					
CO2: summarize the biological productivity.					
CO3: enumerate the environmental features of Indian Ocean.					
CO4: correlate the knowledge gained on Paleo-Oceanography & Sedimentology.					
CO5: compare & contrast the physiography and environmental features of Indian Ocean.					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Marine Chemistry				15
2	Paleo-Oceanography & Sedimentology				15
3	Ocean based Institutes and Industries				15
4	Physiography and Environmental features of Indian Ocean				15
	Total				60
	PRACTICALS				60

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Module	Chemical Oceanography	No. of Hours/Credits 60/4
1	Marine Chemistry	15
	Chemistry of Sea water: Constancy of its composition and factors affecting the composition, major and minor constituents, trace elements classification and their biological role; Thermocline, Halocline, Pycnocline and *Factors influencing the distribution of nutrient elements.	5
	Dissolved gases in the sea water and their role in the environment, CO ₂ system, dissolved O ₂ and oxygen profile, hydrogen sulphide, Dissolved Organic Matter, Oxidation-Reduction Potential of Seawater.	2
	*Nutrients in the ocean, their cycles and factors influencing their distribution: Carbon, Nitrogen, Phosphorus and Silicon.	1
		2
		2
		3
2	Paleo-Oceanography & Sedimentology	15
	Early diagenesis at the Molecular level, Organic Carbon content of Marine sediment, Inorganic & Organic carbon release from deep-sea sediments.	4
	Formation of Fossil Organic Matter, *Molecular Fossils & its application as biological markers.	4
	Molecular Paleo-seawater temperature & climate indicators, Organic Petrography, *Mineralogy-Dating, economic significance & future prospects.	4
	Radioactive tracers in biogeochemistry, *Concept & Applications of Geochemical Models.	3
3	Ocean based Institutes and Industries	15
	Research activities in India & Abroad History, Structure and Mandate of: National Institute of Oceanography, *National Institute of Ocean Technology, National Centre for Antarctic and Polar Research, Indian National Centre for Ocean Information Services, *Scripp's Institute of Oceanography & Mauritius Oceanography Institute.	5
	Minor Ocean based industries: Chemicals and drugs, Minerals, Energy and Climate.	4
	Major Ocean based industries: Shipping, Shipbuilding, Ports and Warehouses, Fishing, Offshore oil and gas, *Recreation and tourism.	6

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

4	Physiography and Environmental features of Indian Ocean	15
	Uniqueness of Indian Ocean	1
	Environmental features: Physical, Chemical, Biological, Geological features of Indian Ocean, Arabian Sea and Bay of Bengal, Monsoon (causes, physics and forecasting), oceans and climate change.	4
	Estuaries: Structure, classification, physico-chemical parameters and productivity.	3
	Typical Estuarine habitats, lakes and backwaters of India:	4
	*Hoogly-Matlah, Godavari estuary and Cauvery estuary, *Chilka lagoon, Lonar Crater Lake, Pulikat lake and Kayamkulam lake, Vembanad lake, Cochin backwaters.	3

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Oceanography Practical II PSMAZOO CNP36		Credits- 02
Based on Chemical Oceanography, PSMAZOO CN306		
Sr. No.	Topic	
1.	Estimation of Salinity (Argentometric / Conductivity method)	
2.	Estimation of Dissolved oxygen - Winkler's method	
3.	Estimation of Free Carbon dioxide	
4.	Estimation of Nitrates-nitrites - Sulphanilamide method	
5.	Estimation of Silicates - Ammonium molybdate method	
6.	Estimation of Phosphate-phosphorus - Fiske Subbarrow method	
7.	Estimation of Hydrogen sulphide	
8.	Determination of pH of sediment.	
9.	Analysis of Textural features of sediment.	
10.	Estimation of Organic Carbon content of sediment - Walkey & Black method	
11.	Estimation of TDS and TSS from Seawater	
12.	Visit to oceanography institute and submission of report	

RECOMMENDED READING:

Essential Reading:

- The oceans - Their Physics, Chemistry and General Biology, Sverdrup, H. U., M. W. Johnson and R. H. Fleming, 1942, Asia Publishing House
- A textbook of Marine Ecology, Nair, B. N. and D. M. Thampy, First Edition 1980, The Macmillan Company of India Limited
- Introductory oceanography, Harold Thurman, Tenth Edition, Prentice Hall. London
- Elements of Marine Zoology, R.V. Tait, Fourth Edition, Butterworth-Heinemann, A division of Reed Educational and Professional Publishing Ltd.
- Sea Shore life of India, B.F. Chapgar, 2008, SIDGWICK and JACKSON, London
- Introduction to Planktology, M. Krishna Pillai, 1986, Himalaya Publishing
- Basic Marine Biology, A.A. Fincham, 1984, British Museum Natural History

Supplementary Readings:

- Marine Geochemistry, Horst D. Schulz Matthias Zabel, 2nd revised, updated and extended 2006 edition, Springer-Verlag Berlin Heidelberg Germany.
- Glimpses of The Indian Ocean, Qasim, S.Z., First Edition 1998, Sangam Books Ltd.
- Oceanography, R. Gordon Pirie, Third Edition, Oxford University Press
- Ecological methods for field and laboratory investigations, P. Michael, 1984, New Delhi; London: Tata McGraw-Hill
- The Seas, Russell & Yonge, Second Edition 1958, Frederick Warne & Co. Ltd.
- Jefferey F. Raymond, Plankton and productivity Vol. I and II, ,
- Marine Biology, Function, biodiversity, ecology, J.S. Levington, Fourth Edition 2013, Oxford University Press.
- Introduction to marine chemistry, J.P. Riley and R. Chester, 1971, Academic Press, London and New Delhi.
- American Public Health Association – 2000, Revised Edition, APHA Press
- Genetics and Fish breeding, Colin E. Purdom, First Edition 1993, Springer Netherlands
- Genetics and Mutagenesis of fish, Schroder J.J., First Edition 1973, Springer, Berlin, Heidelberg
- Marine Pharmacognosy, Dean F. Martin and George M. Padilla, First Edition, Academic Press
- Chemical Oceanography, Frank J. Millero, Fourth Edition, CRC Press, Taylor & Francis Group

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Program: Master of Science (Zoology)				Semester: IV	
Course: Oceanic Resources				Course Code: PSMAZOOCN406	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • To study and inculcate the knowledge on marine resources, marine biotoxins and marine biotechnology • To educate the learners to identify sources of marine pollution and advocate mitigation strategies. 					
Course Outcomes:					
After completion of the course, learners would be able to					
CO1: examine various Marine Resources occurring in the Ocean.					
CO2: classify Marine Biotoxins and interpret their Toxicological effects on organisms					
CO3: identify and compile the avenues of pharmacology in oceanography.					
CO4: summarize the hazards of marine pollution, interpret its impact on biota & suggest the corrective measures.					
CO5: assess the applications of marine biotechnology					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Marine Resources				15
2	Pharmacology of Marine Biotoxins				15
3	Marine Biotechnology				15
4	Marine Pollution and Reclamation				15
	Total				60
PRACTICALS					60

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Module	Oceanic Resources	No. of Hours/Credits 60/4
1	Marine Resources	15
	Marine Resources: Characteristics, formation and management	2
	Sea floor mining: Mineral resources, Deep Sea mud oozes and Ferro-manganese nodules, Oil rigs, gas and sulphur deposits, *Role of ONGC in sea floor exploration.	4 1 6
	Radioactive clock and bioactive compounds from the sea: radionuclides in seawater, uranium series, carbon-14, *age and types of marine organic matter (vitamins, fatty acids, amino acids, sugars, volatile hydrocarbons and black carbon)	6
	Scientific and economical aspects of marine exploration: salts, magnesium, bromine, gold and water.	2
2	Pharmacology of Marine Biotoxins	15
	Introduction: Concept of Biodynamic compounds, Pharmacology of natural product, factors affecting distribution and occurrence of bioactive agents.	4
	Major characteristics: Physical, chemical and physiological properties, *Scientific importance and significance of Biotoxins.	4
	Chemical and Cellular correlates & Applications: Saxitoxin and Tetrodotoxin, Alginic acid.	3
	Toxicological aspects of marine fishes, reptiles, birds and mammals, Sea-Originated Cytotoxic Substances.	4
3	Marine Biotechnology	15
	Role of Biotechnology in marine organisms: Occurrence and role in ocean, Animal and human health impact, *Symbiotic relationship, Biofilm, Hydrothermal vents, Role of Marine microbes in regulation of climate.	4
	Microbes as metabolic engines: Recycling machines, transformational power, limiting nutrients, Ecological relationship, *Microbes for degradation of xenobiotic compound, *Marine microbial sources of bioactive compounds (Antibacterial compounds, Antiviral compounds and Antitumor compounds).	5 3
	Blue Biotechnology: Novel industrial enzymes, food ingredients, biosensors, drug delivery systems and new chemical compounds.	3

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	Techniques in Marine Biotechnology: Isolation of DNA of a fish, Fish Barcoding, Microfluidics-Process & Applications Micro-haemolytic Assay, Fluorescent Antibody Techniques.	
4	Marine Pollution and Reclamation	15L
	Introduction to marine pollution: Impact of anthropogenic activities on ocean and oceanic sediments: Domestic Sewage, Industrial, Heavy Metals, Agricultural - Fertilizers and Pesticides, Oil Pollution, *Ocean dumping, Radioactive and Thermal waste.	5
	Ocean Acidification, *Eutrophication and Toxins, Plastic debris & Microplastic, Sound Pollution, Offshore drilling, *Impact of coastal construction activities and reclamation.	5
	Adaptations, Bioremediation, *Application of Artificial Intelligence in detection of marine pollutants, Mitigation and Conservation Measures.	3
	A blueprint of oceanic and coastal sustainability, Ocean Health Index.	2

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Oceanography Practical II PSMAZOO CNP44 Based on Oceanic Resources PSMAZOO CN406		Credits- 02
Sr. No.	Topic	
1	Extraction of toxins from fish tissues.	
2	Isolation of marine bacteria from fish.	
3	Morphology and staining reaction of isolated bacteria (Gram Staining method).	
4	Motility test of bacteria by hanging drop method.	
5	Biochemical tests for differentiating microbes: Sugar fermentation, Methyl Red Test, Voges Proskauer's Test, Catalase activity, Citrate Utilization Test, Indole Test, Cytochrome Oxidase Test.	
6	To determine ability of bacteria to liquefy gelatin.	
7	To perform glucose oxidative fermentation test.	
8	Antibody Sensitivity Test (DISC method)	
9	Identify, comment on its source and give its economic importance: Ferro-manganese nodules, Gas hydrates, Oil rigs, Hydrothermal vents, Microplastic	
10	Identify and give its significance: Bioactive compounds from <i>Conus magus</i> (Analgesic), <i>Helichondria okadai</i> (Breast Cancer), <i>Tethya crypta</i> (Leukaemia), Red algae <i>Eucheuma/Chondus</i> (Antiviral).	
11	Wet/Dry digestion method for extraction of metals from sediment/water/tissue	
12	Analysis of metals from sediment/water/tissue by AAS method	

RECOMMENDED READING:

Essential Reading:

- Elements of Marine Zoology, R.V. Tait, Fourth Edition, Butterworth-Heinemann, A division of Reed Educational and Professional Publishing Ltd.
- Marine Biology, J.S. Levington, Function, biodiversity, ecology, Fourth Edition 2013, Oxford University Press.
- The oceans - Their Physics, Chemistry and General Biology, Sverdrup, H. U., M. W. Johnson and R. H. Fleming, 1942, Asia Publishing House
- Marine Pharmacognosy, Dean F. Martin and George M. Padilla, First Edition, Academic Press

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

- Chemical Oceanography, Frank J. Millero, Fourth Edition, CRC Press, Taylor & Francis Group

Supplementary Readings:

- A textbook of Marine Ecology, Nair, B. N. and D. M. Thampy, First Edition 1980, The Macmillan Company of India Limited
- Introductory oceanography, Harold Thurman, Tenth Edition, Prentice Hall. London
- Glimpses of The Indian Ocean, Qasim, S.Z., First Edition, 1998, Sangam Books Ltd.
- Basic Marine Biology, A.A. Fincham, 1984, British Museum Natural History
- American Public Health Association – 2000, Revised Edition, APHA Press
- Fish genetics in India, Das P. and Jhingran A.C.G, January 2009, BIO-GREEN BOOKS
- Wealth of India, Vol. IV, 1948, CSIR Publications
- Research methods in Marine Biology, Schlieper, Carl, First Edition 1972, Sidgwick & Jackson Ltd.
- The Seas, Russell & Yonge, Second Edition 1958, Frederick Warne & Co. Ltd.
- Introduction to marine chemistry, J.P. Riley and R. Chester, 1971, Academic Press, London and New Delhi.

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Program: Master of Science (Zoology)				Semester: III	
Course: Biology of the ocean-I				Course Code: PSMAZOOOCN307	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA)	Semester End Examinations (SEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • To acquire the knowledge on oceanic environment and seasons. • To have an understanding of various coastal habitats and its importance. • To have the knowledge on marine life of the sea and their adaptations to oceanic life. 					
Course Outcomes:					
After completion of the course, learners would be able to:					
CO1: develop deeper understanding of oceanic organic production, its measurement and significance.					
CO2: compare various coastal habitats.					
CO3: evaluate role of mangroves in marine ecosystems.					
CO4: recommend conservation strategies for oceanic ecosystems.					
CO5: summarize adaptations of coastal, seashore and benthic communities.					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Fundamentals of Marine Ecology				15
2	Introduction to Coastal Habitats				15
3	Seashore Environment and its Communities				15
4	Biology of deep ocean				15
	Total				60
PRACTICALS					60

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Module	Biology of the Ocean-I	No. of Hours/Credits 60/4
1	Fundamentals of Marine Ecology	15
	Community (Niche: an organism's environmental role; Biological interactions: prey-predator, competition, symbiosis with relevant examples), Concept of trophic cascades	1 3 3
	Biological productivity: Primary, Organic cycles, photosynthesis, chemosynthesis, Measurement of primary production: Standing Stock Measurement (Chlorophyll estimation, Oxygen bottle experiment, Carbon-14 method) and measurement of nutrient uptake., limiting nutrients for growth, Grazing chain, Detritus chain, *Factors regulating production, *Seasonal and global trends in primary production	4 2 1 1
	Secondary and Tertiary Production: Marine Microbial secondary production processes: Marine Microbial secondary producers, *Marine microbes and oceanic nitrogen cycle, Marine microbial food webs	
	Environmental Factors that Affect the Distribution of Marine Organisms: Factors, regulation and production: Light, Temperature, *Salinity-chlorinity relationship, Density, Nutrients, *Upwelling, Turbulence and grazing rate.	
	Ocean Seasons: Winter, Spring, Summer, Autumn w.r.t. latitudinal significance.	
	Mechanism to increase fertility in the seas and Energy Balance Sheet.	
2	Introduction to Coastal Habitats	15
	Hydrographic Classification of Coastal systems Wetland: Introduction and types of Wetland: Tidal Marshes, Swamps, bogs and fens, Functions and values of Wetlands; Threats to Wetlands. *Coastal lagoons, Coastal Sand Dunes	3
	True Mangroves and Mangrove associates Introduction of mangrove ecosystem and types - Black, Red and White, Role/Importance of mangroves – Mangrove as Feeding and Breeding Grounds, Mangrove as Carbon sink/stock, Mangroves in Coastal defense and Pollution Abatement, *Factors influencing mangrove ecosystems	4
	Adaptation of mangrove plants to saline habitat in combating climate change, in sustainable tourism development, as natural barrier to environmental risk and coastal protection, Mangrove	3

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	<p>ecosystem and its evaluation, Mangrove Restoration and Reforestation – case studies, Geospatial tools for mapping and Monitoring Coastal Mangroves</p> <p>Algae, seagrasses and Seaweeds: Introduction of Marine Algae, Sea Weeds and Sea Grass Distribution of algae (zonation), *Types of algae based on pigments present: Chlorophyceae, Pheophyceae and Rhodophyceae, Economic importance of algae. Integrated Coastal Zone Management (ICZM) Coastal Ecosystems of India and Their Conservation and Management Policies Coastal and Marine Protected Areas (MPAs)- Importance and examples of MPAs in India (Example-Thane creek) CRZ 1991 Regulation</p>	<p align="center">3</p> <p align="center">2</p>
3	Seashore Environment and its Communities	15
	<p>Shore environment & stresses on the shore Salient features of the shore environment Patterns and causes of Zonation on the shore Intertidal Zone: characteristics and distinct parts (Lower littoral, Mid-littoral, Upper littoral Zone and Splash Zone) Tidal pools, Sinking sand, Quicksand *Ecological succession in intertidal zones Rocky shore- Adaptations of animals with suitable examples Muddy shore- Adaptations of animals with suitable examples Sandy shore- Adaptations of animals with suitable examples Beaches-Formation, Types and characteristics</p>	<p align="center">2</p> <p align="center">3</p> <p align="center">2</p> <p align="center">4</p> <p align="center">4</p>
4	Biology of deep ocean	15
	<p>Pelagic and benthic systems of the Deep Sea *Physical environment of the Deep Sea *Deep sea hydrothermal vents and cold seeps Methods of study of the organisms of the deep-sea floor Animal-sediment relations in the Deep Sea Adaptation of deep-sea animals Adaptation for life in darkness - Vision, Coloration, Bioluminescence, Behaviour, Feeding, reproduction. Benthic communities Physical factors affecting distribution of communities (Substrate, turbidity, water current, pressure) Biological factors affecting distribution of communities (Selective settlement, competition and predation, interrelationships)</p>	<p align="center">4</p> <p align="center">3</p> <p align="center">4</p>

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	<p>Classification and characteristics of benthic communities Megafauna, Macrofauna, Meiofauna and Microfauna communities; Foraminiferan and Radiolarian Method of collection of macrofauna Inventories of macro fauna occurring in Arabian sea and Bay of Bengal Feeding strategies of benthic communities *Adaptations and importance of benthic communities *Anthropogenic impact on deep sea environment</p>	<p align="center">4</p>
--	---	-------------------------

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Oceanography Practical III PSMAZOOCP37		Credits- 02
Based on Biology of the Ocean- I PSMAZOOCP307		
Sr. No.	Topic	
1	Estimation of primary productivity by light and dark bottle method.	
2	Identification of types of mangroves and principal mangrove species (<i>Avicennia, Rhizophora, Sonneratia, Bruguiera, Aegiceras</i>)	
3	Identification of mangrove associates: (<i>Acanthus, Clerodendrum, Dalbergia, Cynometra, Derris</i>)	
4	Adaptation of marine organisms: Rocky Shore - Chiton, Crassostrea, Rock Crabs, Herdmania, Moray Eels. Sandy Shore - Hermit crab, Murex, Telescopium, Trochus, Sea anemone, Star fish, Sea urchin, Brittle star, Natica, Solen, Paphia and Nautilus. Muddy Shore - Balanoglossus, Amphioxus, Aplysia, Doris, Nereis, Mudskipper	
5	Collection and submission of any five types of molluscan shells.	
6	Locate Marine Protected Areas on map of India/World and describe their significance	
7	Entrepreneurial skill enhancement: Setting up and maintenance of aquarium	
8	Entrepreneurial skill enhancement: Breeding of ornamental fishes	
9	Identification and significance of: a) Proteins Skimmers, Filters & Filtration Equipment b) Salinity tester & Hydrometer c) Test Kits, Additives & supplements for marine aquarium setup	
10	Visit to Mangrove habitat and submission of report	
11	Visit to seashore to observe intertidal organisms and submission of report	

RECOMMENDED READING:

Essential Reading:

- Svedrup H.U., Martin W.J. and Richard H.F., The Oceans: Their Physics, Chemistry and General Biology. Asian Student edition.
- Gupta D. K., Mahendra Phulwaria, Rajesh P. Rastogi 2021. Mangroves: Ecology, Biodiversity and Management, Springer Singapore
- K. Venkatraman and C.H. Satyanarayana, 2012. Coral Identification Manual, Zoological Survey of India

- Integrated Coastal Zone Management, By Erlend Moksness, Einar Dahl, Josianne Støttrup · 2009 Wiley Publishers
- Introduction to Coastal Processes and Geomorphology, R. Davidson-Arnott · 2010 Cambridge University Press

Supplementary Readings:

- Nair N.B. and Thampi D.H., A textbook of marine ecology, T-M-H.
- Harold Thurman, Introductory oceanography, Prentice Hall. London.
- Qasim S.Z., Glimpses of Indian Ocean, Sangum Bodes Ltd. London. Navya Printers, Hyderabad.
- P. Michal, Ecological methods for field and laboratory investigations.
- R.V. Tait, Marine Zoology, Oxford press.
- B.F. Chapgar, Sea Shore life of India, SIDGWICK and JACKSON, London
- A.A. Fincham. Basic Marine Biology, British Museum Natural History.
- Jefferey F. Raymond, Plankton and productivity, Vol. I and II.
- J.S. Levington, Marine Biology, Function, biodiversity, ecology. Oxford University Press.
- J.P. Rilcy and R. Chester, Introduction to marine chemistry, Academic Press, London and New Delhi.
- Das P. and Jhingran A.C.G., Fish genetics in India.
- Colin E. Purdon, Genetics and Fish breeding, Chapman and Hall.
- Schroder J.J., Genetics and Mutagenesis of fish, Chapman and Hall.
- Frank J. Millero, Chemical Oceanography, CRC Press, Taylor & Francis Group.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: Master of Science (Zoology)				Semester: IV	
Course: Biology of the Ocean-II				Course Code: PSMAZOOCN407	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • To be familiarized with diversity and behaviour of marine invertebrates and vertebrates. • To acquire knowledge on planktonic organisms of oceans. • To gain information about adaptations of Arctic and Antarctic animals 					
Course Outcomes:					
After completion of the course, learners would be able to:					
CO1: paraphrase the mechanism of coral reef formation					
CO2: summarize causes of coral bleaching and threats to coral ecosystem.					
CO3: describe various phenomena associated with life of plankton					
CO4: grade the adaptations of marine organisms to extreme environmental conditions.					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Invertebrate Fauna of the marine environment				15
2	Planktology				15
3	Vertebrate Fauna of the marine environment				15
4	Ecology of Polar Regions				15
	Total				60
PRACTICALS					60

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	Preparing and quantifying Zooplankton Plankton as an indicator species availability/ occurrence. Phenomenon associated with plankton: Vertical and horizontal migration, Red tide, Deep scattering layer. Phytoplankton-zooplankton relationship and Plankton in relation to Fisheries.	4
3	Vertebrate Fauna of the marine environment	15
	Superclass: Agnatha (features and examples) Superclass: Pisces (features and examples) Marine Reptiles. Some common sea snakes and their adaptation Nesting behaviour and status of sea turtles and their conservation. Marine birds (Sea Birds) (plovers and turnstones / Heron / Avocets & stilts / sandpipers and curlews etc.) Marine mammals: *Communication in Dolphin, their use in military warfare (military dolphin) and in the human services, Dolphins, porpoises, whales and manatees - their present status and need for conservation. Adaptation of marine life to an aquatic habitat. *Marine vertebrate interactions. Migration and schooling behaviour in marine organisms. Recent approach to marine biodiversity monitoring- Environmental DNA (eDNA)	2 3 2 3 2 2 1
4	Ecology of Polar Regions	15
	The Arctic region: Definition and History. The Ice Age and discovery of the Arctic Region. Environmental conditions and Arctic phenomenon: Permafrost, Blizzards, High velocity winds, Aurora Borealis, Glaciers, Icebergs, Snowstorms, Six Months light period alternating with six months of darkness and twilight Adaptations of animals to extreme environmental conditions - Thick fur, White body color for camouflage, Sharp eyesight and Keen sense of smell. Fauna of the Arctic: Polar Bear, Seals, Walruses, Reindeer, Moose, Arctic fox and Sand Wolf, Snow Owl Hare, Arctic tern, Narwhale, Musk Ox and arctic ground squirrel. The Antarctic Region-Definition, History and Discovery, Environmental conditions: Severe cold / winters little or no vegetation, Icebergs and Ice floes *Adaptations of animals in penguins, Fur coat in seals, blubber in whales, Flippers, Small extremities, Specialized adaptations of emperor penguins,	1 3 2 2 2 3

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	<p>Peripheral circulatory system modification like in Orca and other whales.</p> <p>Animals of thaw Antarctic Region: Various species of penguins, seals, whales, Krill (<i>Euphausiasuperba</i>)</p> <p>*India's first Expedition to the Antarctica, establishment of station - Dakshin Gangotri. Maitri - India's second permanent station on Antarctic. Bharati station, Present findings. India's expedition to Antarctica by <i>Sagar Sampada</i>.</p>	<p align="center">2</p>
--	---	-------------------------

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Oceanography Practical III PSMAZOOCP47		Credits- 02
Based on Biology of the Ocean- II PSMAZOOCP407		
Sr. No.	Topic	
1	Plankton analysis - separation from sample and mounting of plankton.	
2	Laboratory procedure for quantitative estimation of plankton by wet weight, weight displacement and counting method	
3	Preparation and submission of permanent slides of any five planktonic forms	
4	Study of Gonyaulax, Noctiluca as organisms causing red tides.	
5	Mounting of five forms of Foraminiferan shells	
6	Types of Corals- Fungia, Meandrina, Madrepora, Gorgonia, Tubipora, <i>Corallium rubrum</i>	
7	Identification of some coral reefs organism - Parrot fishes, Angel fish, Shrimps, Carpet anemone, Eels, Sea horses, Lion fish, Molluscs, Echinoderms and Sea snakes.	
8	Identification and Classification of marine animals: Reptiles - Olive Ridley turtle and Hawksbill turtle Birds - Penguin, Egret, Seagull, Terns, Sandpiper, Reef heron, Flamingoes Mammals - Baleen whale and Dolphin.	
9	Identification of organisms from the polar worlds: Walrus, Reindeer, Moose, Arctic fox and Wolf, Snow Owl, Hare, Arctic tern, Narwhale, Musk Ox and Arctic ground squirrel.	
10	Preparation & submission of five different herbaria of marine algae.	
11	Visit to observe migratory birds and submission of report	

RECOMMENDED READING:

Essential Reading:

- Zade S.B., Khune C.J, Sitre S.R. and Tijare R.V.P, Principles of aquaculture, First Edition 2011, Himalaya Publishing House
- Jennings Simon, Kaiser M.J and Reynold J.D., Marine Fisheries Ecology, Reprinted 2003, Blackwell Publishing
- Harold Thurman, Introductory oceanography, Tenth Edition, Prentice Hall. London
- Claudia Castellani, Claudia Castellani (Marine biologist), Martin Edwards, 2017. Marine Plankton-A Practical Guide to Ecology, Methodology, and Taxonomy. Oxford University Press

Supplementary Readings:

- M. Krishna Pillai, Introduction to Planktology, 1986, Himalaya Publishing
- Santosh, Kumar and Manju Tembhre, Fish and Fisheries, New Center Block Agency
- Ross, David A., Introduction to Oceanography, 1977, Second Edition, Prentice Hall
- A.A. Fincham, Basic Marine Biology, 1984, British Museum Natural History
- Ross, David A., Introduction to Oceanography, 1977, Second Edition, Prentice Hall
- K. Venkatraman and C.H. Satyanarayana, 2012. Coral Identification Manual, Zoological Survey of India
- Krishnamoorthy Venkataraman and Chandrakasan Sivaperuman, 2014. Marine Faunal Diversity in India-Taxonomy, Ecology and Conservation, Elsevier Science

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Program: Master of Science (Zoology)				Semester: III	
Course: Fisheries I				Course Code: PSMAZOO CN308	
Teaching Scheme			Evaluation Scheme		
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%

Learning Objectives:

- To acquire the knowledge on Elasmobranchs (Cartilaginous) fishery and Fin- fish (Teleost) fishery of the Indian Exclusive Economic Zone and adjoining seas.
- To acquire the knowledge on biology of important fishery resources and methods of stock assessment.
- To study the diversity of Marine fishery resources and their conservation and management including policies.
- To study preservation fish and fishery products, value addition and economic importance.
- To study different methods of capturing fish (Craft and Gear) and their utilization.

Course Outcomes:

After completion of the course, learners would be able to

CO1: correlate the important marine fishery resources to get in-depth biological aspects of marine fishery.

CO2: estimate the stock and status of seasonal trends in production.

CO3: distinguish the knowledge for conservation & management of marine fishery resources.

CO4: equip with methods of fish preservation to minimize wastage of fish resources.

CO5: summarize the value addition mechanism of marine fishery resources and their economic importance.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	Marine Fisheries	15
2	Crafts, Gears and National & International Institutes of Fishery	15
3	By-products and Value-added products	15
4	Fish Parasites and Fish pathology	15
	Total	60
PRACTICALS		60

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Module	Fisheries I	No. of Hours/Credits 60/4
1	Marine Fisheries	15
	<p>Introduction, Taxonomy, Fishery (Demersal, pelagic and Oceanic fisheries) & distribution, craft & gear, biological studies, stock assessment studies, preservation & value addition, conservation & management and economic importance.</p> <p>Elasmobranchs (Cartilagenous fishes): Sharks: <i>Carcharhinus</i> spp., <i>Sphyrna</i> spp., <i>Scoliodon</i> spp. Skates: <i>Rhynchobatus</i> spp. Rays: <i>Trygon</i> spp. Fin fishes (Teleost/ Bony fishes)</p> <p>Demersal Fishery Resources: Pomfrets (<i>Pampus argenteus</i> (Euphrasen, 1788), <i>Pampus chinensis</i> (Euphrasen, 1788) Ribbon fish (<i>Trichiurus</i> spp.) Flat fish / Sole fish (<i>Cynogossus</i> spp. & <i>Psettodes erumei</i> (Bloch & Schneider, 1801) Sciaenids (<i>Johnius</i> spp., <i>Otolithus</i> spp., <i>Otolithoides biauritus</i> (Cantor, 1849) Polynemids (<i>Eleutheronema tetradactylum</i> (Shaw, 1804) <i>Leptomelanosoma indicum</i> (Shaw, 1804) <i>Filimanus heptadactyla</i> (Cuvier, 1829) Carangids (<i>Megalopsis cordyla</i>) Perches (<i>Lutjanus</i> spp.).</p> <p>Pelagic Fishery Resources: Oil Sardine (<i>Sardinella longiceps</i>) Indian Mackerel (<i>Rastrelliger kanagurta</i>) Bombay duck (<i>Harpodon nehereus</i>) *Seer fish (<i>Scombermorus guttatus</i>, <i>Scombermorus commerson</i> and <i>Scombermorus lineolatus</i>) Clupeids (<i>Chirocentrus</i> spp.) Anchovies (<i>Coilia dussumieri</i>.)</p> <p>Oceanic Fishery Resources: Tunas and Bonitos (<i>Thunnus</i> spp., <i>Katsuwonus</i> spp., <i>Sarda</i> spp., <i>Gymnosarda</i> spp.) *Bill fishes (<i>Istiophorus</i> spp. (Sail fish), <i>Xiphias</i> spp. (Sword fish), <i>Makaira</i> spp. (Marlins)</p>	<p>5</p> <p>2</p> <p>7</p> <p>1</p>
2	Crafts, Gears and National International Institutes of Fishery	15
	Crafts and gear of west and east coast of India. Crafts:	2

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

	<p>Traditional, Motorized and Mechanized crafts. Trawlers and long liners.</p> <p>Gears: Gill nets, purse seine, shore seine, cast net, doll net, hand line, pole and line, trap fishing, trawling & longlining and the method of operation.</p> <p>*Boat building material: Construction, design of boats.</p> <p>*Fish finding devices: Sonar, Echo sounder and GPS. Mobile app GEMINI developed by the INCOIS.</p> <p>Ghost fishing</p> <p>Carbon foot print by fishing boats</p> <p>Role of National and International Institutes of Fisheries:</p> <p>National Institutes of Fisheries</p> <p>Fishery Survey of India (FSI)</p> <p>Central Marine Fisheries Research Institute (CMFRI)</p> <p>Central Institute of Fisheries Education (CIFE)</p> <p>Central Institute of Fisheries Nautical and Engineering Training (CIFNET)</p> <p>National Bureau of Fish Genetic Resources (NBFGR)</p> <p>National Fisheries Development Board (NFDB)</p> <p>Central Institute of Brackish water Aquaculture CIBA</p> <p>Central Institute of Fisheries Technology CIFT</p> <p>International Institutes of Fisheries:</p> <p>Food and Agriculture Organization (FAO)</p> <p>Indian Ocean Tuna Commission (IOTC)</p>	<p>3</p> <p>1</p> <p>1</p> <p>7</p> <p>1</p>
3	By-products and Value-added products	15
	<p>*Proximate composition of fish meat and products.</p> <p>Introduction to by-products: Fish protein concentrate, Fish maws/ Isinglass, Fish Hydrolysates, Chitin, Chitosan, Glucosamine hydrochloride, Gelatin, Fish silage Surimi and imitation products, Pearl essence.</p> <p>Different types of value-added products from fish and shell fish: Fish / Prawn pickle, Fish wafers, Fish fillets, Prawn chutney (<i>Acetes indicus</i>), Fish soup powder Fish / Crab steaks, RTE (Ready to Eat), Battered and Breaded products, Marinated tandoori prawns, Prawn curry and different canned products.</p> <p>*Good manufacturing practices: Health and training of personnel, hygiene.</p> <p>Types of fish spoilage and post mortem changes</p> <p>Autolysis, Bacterial Spoilage, Chemical Spoilage and Rigor Mortis</p> <p>Methods of fish preservation</p> <p>Salting (Dry and Wet), Drying, Smoking (Long and Hot), Chilling, Freezing, Canning and Pickling</p>	<p>2</p> <p>5</p> <p>5</p> <p>3</p>
4	Fish Parasites and Fish pathology	15
	*Viral diseases, prophylaxis and preventive measures.	4

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Bacterial, fungal, protozoan infections and treatment. *Crustacean infections and treatment.	6
Physiological disorders (Dropsy) / diseases and treatment.	2
Fish parasites: Round worms and Tapeworms.	3
Environmental stressors	

***marked topics are to be taken for seminar**

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

Oceanography Practical IV PSMAZOOCP38		Credits- 02
Based on Fisheries- I PSMAZOOCP308		
Sr. No.	Topic	
1	<p>List of Marine fishes:</p> <p>Elasmobranchs: Family - Carcharinidae: <i>Scoliodon laticaudus</i> Müller & Henle, 1838 <i>Sphyrna zygaena</i> (Linnaeus, 1758) Family - Rhinobatidae: <i>Rhynchobatus djeddensis</i> Family- Trygonidae: (<i>Maculabatis gerrardi</i> (Gray, 1851) <i>Himantura uarnak</i> (Gmelin, 1789)</p> <p>Teleost's: Family- Percidae: <i>Lutjanus johnii</i>, <i>Therapon jarbua</i> (<i>Holocentrus servus</i>), <i>Pristipoma maculatus</i>, <i>Nemipterus japonicus</i>, <i>Gerres filamentosus</i> Cuvier, 1829, <i>Lates Calcarifer</i>, <i>Epinephelus diacanthus</i> (Valenciennes, 1828) Family - Scatophagidae: <i>Scatophagus argus</i> Family - Mullidae: <i>Upeneus vittatus</i> (Forsskål, 1775) Family - Polynemidae: <i>Eleutheronema tetradactylum</i> Family - Sciaenidae: <i>Sciaena diacanthus</i>, <i>Johnius dussumieri</i>, <i>Johnius carouna</i>, <i>Johnius elongatus</i>, <i>Johnius glaucus</i>, <i>Otolithoides biauritus</i> Family - Trichuridae: <i>Trichiurus spp.</i> Family - Carangidae: <i>Caranx mabbaricus</i>, <i>Caranx roltleri</i>, <i>Apolectis niger</i> Family - Stromateidae: <i>Pampus argenteus</i>, <i>Pampus chinensis</i> Family - Scombridae: <i>Scomberomorus guttatus</i>, <i>Scomberomorus commerson</i> Family - Sillaginidae: <i>Platycephalus sihamus</i> Family - Gobiidae: <i>Periophthalmus spp.</i>, <i>Boleophthalmus spp.</i> Family - Sphyraenidae: <i>Sphyraena spp.</i> Family - Bregmacerotidae: <i>Bregmaceros maclellandi</i> Family - Psettodidae: <i>Psettodes erumei</i>, Family - Cynoglossidae: <i>Cynoglossus arel</i> (<i>Cynoglosses macrolepidotus</i>) Family - Ariidae: <i>Plicofollis dussumieri</i> (Valenciennes, 1840)</p>	

	<p>Family - Synodontidae: <i>Saurida tumbil</i> (Bloch, 1795) <i>Harpadon nehereus</i> (Hamilton, 1822) Family - Belonidae: <i>Strongylura strongylura</i> (van Hasselt, 1823) Family - Hemiramphidae: <i>Hemiramphus archipelagicus</i> (Collette & Parin, 1978) Family - Clupeidae: <i>Pellona</i> spp, <i>Sardinella longiceps</i> Family - Chirocentridae: <i>Chirocentrus dorab</i> Family - Muraenesocidae: <i>Congresox talabonoides</i> (Bleeker, 1853)</p>
2	<p>Biological Studies: Studies on maturation and spawning including fecundity and ova diameter measurements through frequency polygons. Food and feeding habits of fish.</p>
3	<p>Craft and Gear Studies of East and West coast Identification of crafts and gears. (to be classified as Non-motorized/ Motorized/ Mechanized) Crafts used on the East Coast: Catamaran Masula Boat Nauka & Dinghi Tuticorin Boats Crafts used on the West Coast: Dug-out canoes Plank-built canoes Outrigger boat Built up boats (Satpati type/Ratnagiri type/Trawler) Marine Fishing Gears Seines: Boat Seine Shore Seine Danish Seine Beach Seine Purse Seine Trap net Drop net Cast net Drift net & Gill net Scoop net & Dip net Hooks & Lines Trawl nets Advantages and disadvantages of commonly used craft and gears, especially harmful gears.</p>
4	<p>Morphometric and Meristic studies: Study of relationship between total length and standard length/head length/body depth length/body weight, fin rays & spines count, gill rakers count etc. and deriving fin formula. Types of fins and scales. Bucco pharynx and its modification in fishes.</p>
5	<p>Culinary expertise in Prawn pickle / Fish burger making</p>
6	<p>Demonstration of Fish fillet.</p>

7

Visit to any fish landing center or local fish market and submission of report.

RECOMMENDED READING:

Essential Reading:

- Marine Fisheries of India, Bal, D.V. and K.V. Rao, 1990, Tata McGraw Hill Publishing Company Limited, New York
- Fishery Biology and Aquaculture, Shanmugam, K, 1990, Leo Pathippagam, Madras, India
- Principles and Practices, Pillay T. V. R, Aquaculture, 1988, Fishing News Books
- Handbook of fisheries and aquaculture, S. Ayyappan, 2006, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research
- Fish Biodiversity of India, D. Kapoor, Rajesh Dayal, A. G. Ponniah, 2002, National Bureau of Fish Genetic Resources
- Course manual in fishing technology, Latha Shenoy, CIFE, Versova, Mumbai
- Crafts and Gear of India, Shrikrishnan and Latha Shenoy, ICAR Pub
- FAO, The state of World Fisheries and Aquaculture, yearly publication, Rome, Italy. FAO Website.

Supplementary Readings:

- Fish and Fisheries in India, Jhingran V.G, Third Edition 1975, Hindustan Pub. Corporation – New Delhi
- Prawn and prawn fisheries of India, Kurian and Sebastian, 1986, Hindustan Publishing Corporation
- Fisheries and Aquatic resources of India, D. Dholakia, 2004, Daya Publishing House, Delhi
- India's Ocean Policy, Sharma, R.C. and P.C. Sinha, 1994, Khama Publishers, New Delhi
- General and Applied Ichthyology, Gupta and Gupta, 2006, S Chand Pub.
- FAO Species Identification Sheets for fishery purposes. Western Indian Ocean (Fishing area 51) and Eastern Indian Ocean (Fishing area 57), Vol. I-V W. Fischer and G. Bianchi, 1984, FAO, Rome
- Fishes of the world, Nelson, J. S., 5th ed., 2006, John Wiley & Sons Inc., New York
- The Dynamics of food and feeding habits of some marine fishes, Qasim, S. Z, 1972
- An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters, Qasim, S. Z, 1973 *Fauna of India and Adjacent countries*. Talwar, P. K, Zoological Survey of India, Calcutta, 1995

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Program: Master of Science (Zoology)				Semester: IV	
Course: Fisheries - II				Course Code: PSMAZOOCN408	
Teaching Scheme				Evaluation Scheme	
Lecture (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment Evaluation (CAE)	Term End Examinations (TEE)
04	04	-	04	25%	75%
Learning Objectives:					
<ul style="list-style-type: none"> • To study different commercial shell-fish fisheries of Indian Ocean and Seas. • To study the exploitation patterns of the shell-fish fisheries • To study the economic importance of Crustacean and molluscan fisheries. 					
Course Outcomes:					
After completion of the course, learners would be able to					
CO1: evaluate commercial values of shell-fish fisheries.					
CO2: appraise the economic importance of shell-fish fisheries with respect to fisherman community.					
CO3: summarize daily nutritional requirements of cultivable fishes and apply the knowledge to make fish culture economically viable.					
Outline of Syllabus: (per session plan)					
Module	Description				No of Hours
1	Shellfish fisheries: (Crustacean and Molluscan fisheries)				15
2	Marine Ornamental Fishes, Brackish Water Fishes and Aquaculture/ Mariculture				15
3	Population Dynamics				15
4	Coastal Zone & EEZ: Problems and prospects				15
	Total				60
PRACTICALS					60

Module	Fisheries II	No. of Hours/Credits 60/4
1	Shellfish fisheries: (Crustacean and Molluscan fisheries)	15
	<p>Introduction, Taxonomy, Distribution, Fishery, Crafts and Gear, Utilisation or Economic importance of Crustaceans and Molluscs</p> <p>Crustacean fisheries</p> <p>Shrimps (<i>Penaeus spp.</i>, <i>Metapenaeus spp.</i>, <i>Acetes spp.</i>) Difference between Penaeid and non-penaeid shrimp Lobsters (<i>Panulirus spp.</i>, <i>Thenus spp.</i>) Squilla (<i>Squilla spp.</i>) Crabs (<i>Scylla serreta</i>, <i>Portunus spp.</i>, <i>Charybdis spp.</i>)</p> <p>Molluscan fisheries</p> <p>Cephalopods Family: Loliginidae: Indian Squid (<i>Loligo spp.</i>) Family: Sepiidae: Cuttle fish (<i>Sepia spp.</i>) Family: Octopodidae: Octopus (<i>Octopus spp.</i>)</p> <p>Pelecypods Family: Veneridae: Clams (<i>Meretrix spp.</i>) Family: Pteriidae: Oysters (<i>Pinctada spp.</i>) Family: Mytilidae: Mussels (<i>Perna spp.</i>)</p> <p>*Gastropod shells Family: Muricidae: <i>Thais carinifera</i> Family: Pisaniidae: <i>Cantharus spiralis</i> Family: Babyloniidae: <i>Babylonia spirata</i> Family: Epitoniidae: <i>Acrilla acuminata</i> Family: Trochidae: <i>Trochus radiatus</i></p> <p>Sea Food poisoning:</p> <p>Paralytic shellfish poisoning Diarrhetic shellfish poisoning. Amnesic shellfish poisoning Ciguatera poisoning</p> <p>Nutritional requirements of cultivable shellfish:</p> <p>Feed formulation and manufacturing, Forms of feeds: wet, moist, dry, mashes, feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage, use of preservatives and antioxidants</p>	<p>5</p> <p>4</p> <p>2</p> <p>4</p>
2	Marine Ornamental Fishes, Brackish Water Fishes and Aquaculture/ Mariculture	15
	<p>*Marine ornamental fishes:</p> <p>Family: Scaridae: Parrot fish; <i>Callyodon sps.</i> Family: Chaetodontidae: Butterfly fish; <i>Chaelod sps.</i> Family: Pomacanthidae: Angel fish; Centropyge</p>	7

**SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben
Jivanlal College of Commerce & Economics (AUTONOMOUS)**

Oceanography Practical IV PSMAZOOOCNP48		Credits- 02
Based on Fisheries- II PSMAZOOOCN408		
Sr. No.	Topic	
1	Identification of Shrimps / prawns using key.	
2	Crustacean fishery: Shrimps (<i>Penaeus spp.</i> , <i>Metapenaeus spp.</i> , <i>Parapaeneopsis stylifera</i> , <i>Nematopalaemon spp.</i> , <i>Acetes spp.</i>) Lobsters (<i>Panulirus spp.</i> , <i>Thenus spp.</i>) Crabs (<i>Scylla serrata</i> , <i>Portunus spp.</i> , <i>Charybdis spp.</i>)	
3	Molluscan fishery (<i>Meretrix spp.</i> , <i>Perna viridis</i> , <i>Kataysia spp.</i> , <i>Solen kempfi</i> , <i>Crassostrea spp.</i> , <i>Xancus pyrum</i> , <i>Thais spp.</i> , <i>Babylonia spp.</i> , <i>Trochus spp.</i> , <i>Sepia spp.</i> , <i>Loligo spp.</i>)	
4	Study of marine fouler and borer: Balanus, Lepas, Crassostrea, Mytilus, Green algae, Piddocks, Shipworm.	
5	Study of marine ornamental fishes: Parrot fish, Angel fish, Butterfly fish, Puffer fish, Groupers. Aquarium fish feed and composition - Dry, wet and live feeds	
6	Project: Socio-economics of fisherman community of different areas. Comparative analysis of any Co-operative societies with reference to their Progress for 3 years. Visit to local fish market to identify commercially important shell fishes and prepare a report	
7	Each student can make an attempt to identify the crustacean diversity, length-weight and Age-growth of fishes, fouling-boring organisms and their impacts.	
8	Mariculture aspects: Past, Present and Future- report submission	
9	Feasibility report / Detailed Project report	

RECOMMENDED READING:

Essential Reading:

- Prawn and prawn fisheries of India, Kurian and Sebastian, 1986, Hindustan Publishing Corporation
- Fishery Biology. A study in population dynamics, Cushing, D.H., 1968, Univ. Wisconsin press, Madison
- Fish population dynamics: A course manual, Devaraj, M., 1983, Central Institute of Fisheries Education Bull., 3 (10): 83-89
- Introduction to tropical fish stock assessment, Part 1 & 2. Manual, Sparre, P., Ursin, E. and Venema, S. C., 1989, Food and Agriculture Organisation of the United Nations Fisheries, Rome.

- Coastal Zone Management, Parimal Sharma, 2008, Global India Publications, New Delhi
- Coastal Zone Management In India, Vol.1, R. Korakandy, 2005, Kalpaz Publications
- Fouling Organisms of the Indian Ocean, R. Nagabhushanam, 1997, CRC Press
- Marine Ornamental Fish Resources of Lakshadweep, V. Sriramachandra Murty, 2002, Central Marine Fisheries Research Institute

Supplementary Readings:

- Crafts and Gear of India, Shrikrishnan and Latha Shenoy, ICAR Pub
- Fisheries and Aquatic resources of India, D. Dholakia, 2004, Daya Publishing House, Delhi
- Marine Fisheries of India, Bal, D.V. and K.V. Rao, 1990, Tata McGraw Hill Publishing Company Limited, New York
- India's Ocean Policy, Sharma, R.C. and P.C. Sinha, 1994, Khama Publishers, New Delhi
- The Living Ocean Understanding & Protecting Marine Biodiversity, Miller, B.T and J.G. Catena, 1991
- General and Applied Ichthyology, Gupta and Gupta, 2006, S Chand Pub.
- Text Book of Fish Biology and Indian Fisheries, Dr. R. P. Parihar, Central Pub. House Allahabad.
- The Fishes of India; Being a natural history of The Fishes known to inhabit the seas and fresh waters of India, Francis Day, Burma, and Ceylon, 1994, Jagmander Book Agency New Delhi
- FAO Species Identification Sheets for fishery purposes. Western Indian Ocean (Fishing area 51) and Eastern Indian Ocean (Fishing area 57), Vol. I-V, W. Fischer and G. Bianchi, 1984, FAO, Rome
- FiSAT II, 2005, User's manual. Gayanilo, Jr. F.C., Sparre, P. and Pauly, D., Food and Agriculture Organization. Rome
- Gulland, J. A., Fish Stock assessment, 1983, A manual of basic methods (FAO).
- Sparre, P., Ursin, E. and Venema, S. C., 1989. Introduction to tropical fish stock assessment. Part 1 & 2. Manual. Food and Agriculture Organisation of the United Nations Fisheries, Rome.
- Parimal Sharma, 2008. Coastal Zone Management, Global India Publications, New Delhi.
- R. Nagabhushanam, 1997. Fouling Organisms of the Indian Ocean, CRC Press.
- V. Sriramachandra Murty, 2002. Marine Ornamental Fish Resources Of Lakshadweep, Central Marine Fisheries Research Institute