

# UNIVERSITY OF MUMBAI



**Program: B.Sc.**

(Credit Based Semester and Grading System)

**Course: Marine Science**  
(Applied Component)

**Syllabus for Semester V & VI**

(with effect from the academic year 2017-18)

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## **PREFACE**

Applied Component was introduced for T. Y. B. Sc. class in the academic year 1979-80 with a view to enhance the essence for employability. The syllabus is a blend of concepts with four electives. It gives me immense pleasure to present these four applied component courses namely Marine Science, Fishery Biology, Economic Entomology and Environmental Science under the umbrella of BOS in Zoology.

In the syllabi of these applied components, applied topics having commercial propositions have been incorporated that further adds to the enhancement of entrepreneurial potential and skills amongst the learners. In the past our syllabus focused mainly on theory as a way of providing knowledge base and preparation for students. We have attempted to go beyond this tradition, while doing so, equal emphasis is laid on theory and corroborative practicals. From the academic year 2011-12, the University has introduced Credit Based Semester and Grading System (CBSGS). Accordingly the existing syllabi of these applied components were restructured to fit into the CBSGS pattern. The concept of flexi syllabus was introduced offering opportunity to learners to study any four out of a total of eight units in each course. Now that the syllabus is restructured and to be introduced from the academic year 2017-2018, we have included a novel concept of open unit and case studies. This approach, I'm sure will enhance the critical and analytical thinking abilities of the students.

I take this opportunity to thank the experts in various field for giving valuable, beneficial and constructive suggestions during framing of the syllabus. The syllabus committee under the convenorship of Mr. Vinayak Dalvie has done a commendable job of timely framing the syllabus with a highest degree of precision and accuracy. While appreciating the efforts, I also express my thanks and heartfelt gratitude to the entire team.

– Dr. Anita Jadhav  
Chairperson  
Ad-hoc, BOS in Zoology

**PREAMBLE**

As a convener when I mooted the concept of flexi-syllabus, first of its kind, in the academic year 2009-10 it was grossly misconstrued. To add to it I also placed an idea of including case studies and introducing a new concept of "Open Unit". Both were rejected then. I had also proposed a new subject "Entrepreneurial and Industrial Biology" in place of the existing Applied Components usually offered by the students of Biological Sciences. 20 workshops in different districts with teachers and students of various subjects were conducted to explain these four concepts. A twenty one days refresher course for teachers, sponsored by UGC was also conducted in the new subject of "Entrepreneurial and Industrial Biology" which was much appreciated by the then Director of NAAC, Prof H. A. Ranganath, who is from Biological Sciences, understanding the potential of the subject. However, implementation was postponed for technical reasons thus permitting innovation limited to the flexi-syllabus, implemented in 2010-11, which has inherent capacity to cater to the diverse needs of the region and the industry by allowing students and teachers to choose a desired capsule of eight topics, with various permutations and combinations from the menu of sixteen based on the interest, resources, expertise and need. It took care of a range of students by also providing learners' space to high IQ students. Yet the possibility of exclusion of some important topics cannot be ruled out apart from some new avenues developed during the lag phase of revision of syllabi. Open unit will permit a good teacher to keep pace with the development and adopt latest topics instantly without waiting till it becomes obsolete in the gap of 5 years that the University generally takes to revise the syllabus. It may also allow students to learn the existing topic in more details and depth under the open unit thus making them specialized in need based areas enhancing employability. Assignments would add to their understanding of Govt schemes, regulations and market, while projects will augment Business Sense or Scientific Acumen, as the case may be. Case studies and simulations, introduced for the first time in Zoology, would pose challenge for true application of knowledge to real life situations with thought provoking questions demanding analytical solutions. Pedagogy of such dynamic syllabus will range from use of ICT in the class to teaching directly in the field with a blend of participative and experiential learning with group dynamics gaining true knowledge apart from developing personality of the students and above all making them apply 'Common Sense' which is the essence of life. I am sure dedicated team of Zoologists which has placed the subject on top in the past 5 years is poised to make it a success in every college befitting the purpose of introducing applied component by the University in the academic year 1979-80.

– VINAYAK DALVIE  
Convener,  
Syllabus Committee

### **PEDAGOGY**

The concept of having a flexi syllabus is a unique feature of this syllabus and implementing it creatively and diligently would be a meaningful exercise. This would ensure that learner and facilitator have the liberty to select any four units out of eight which can be decided by both teacher and students of the course collectively. While selecting, both shall ensure that it is done systematically, maintaining the relevance of topics in every unit taught in the semester. An exciting aspect adding a new dimension to the flexi-syllabus concept is the idea of making various permutations and combinations of the units in every semester. It would take into consideration the need, resources and the expertise that the department, college possesses/ provides or can make available.

A major thrust should be to direct the learner to maximize the use of ICT, watch films related to the topics, You-tube clippings and extra read material in the form of articles and magazines for all the topics, 'Buzz sessions' should be held after showing films, short video clippings etc., whereby the learner is encouraged to summarize the contents, or debate or ask questions related to the topics. This exercise would initiate a 'thought process' with respect to the subject, ensuring that the learner develops a habit of ruminating over the information to gain conceptual clarity and insights.

Field trips, study tours and Industrial visits both short and long are recommended, relevant to the units prescribed and selected for teaching so as to provide desired exposure. For e.g. Units consisting of zonation in sea, deep sea fishing & research vessels, mechanised boat and modern gears, should not be taught only in class-rooms but, on locations, to promote experiential learning.

'Case studies' should be conducted through discussion in a group of 10 students for every case. It must be developed and presented by the facilitator (teacher) with thought provoking approaches expecting students to think analytically and derive an appropriate solution after critically evaluating all the solutions, given within the group.

The inclusion of the concept of 'open unit' encourages the creative teacher-facilitator to choose a topic from the existing units which needs to be further elucidated or taught or researched so as to gain in depth knowledge on the topic and can hence be covered extensively. On the other hand the topic taught could also be a 'need based' one either comprehensively covered by the syllabus or totally ignored. If the facilitator has the ability to include a newly developed area arising due to the need of such a study, within the vicinity, then it may be included in the open unit with the consent of the Head of the Department and the Principal of the institution.

This new syllabus takes into consideration the applied approach, and therefore the topics chosen are practical although few theory based topics are retained. All the practical experiments are application oriented and simple since the learner has had exposure to them while performing them in the former years or in their mainstream subject covered under the science streams. While performing them the learner develops the aptitude of putting them into practice scientifically, logically and appropriately for studying various aspects of marine fauna and flora, hydro-biological parameters and new trends emerging in the vast but under-explored fields of oceans/seas. Facilitators must encourage the learners to comprehend and generate ideas for the applicative value of these experiments.

The syllabus has also incorporated the skeleton question paper for the practical examination and the model question paper for the theory units so as to resolve any doubts and ensure uniformity in the drafting of the question paper pattern for the semester end examination in all affiliated colleges.

Co-Convenors  
Syllabus Committee

**T. Y. B. Sc.**  
(Credit Based Semester and Grading system)  
**Marine Science (Applied Component)**  
**Syllabus**  
(to be implemented from the academic year 2017-18)

**Semester V**  
**Oceanography & Capture Fisheries**

Theory (Any four units to be opted)				
Course	Unit	TOPIC	Credits	L/Week
<b>USACMSC501</b>	1	Zonation in the sea and marine biodiversity	2	4
	2	Physical oceanography and ocean related climatic changes		
	3	Chemical oceanography		
	4	Oceanographic instruments		
	5	Sustainable fishery		
	6	Deep sea fishing vessels and research vessels.		
	7	Mechanized boat and modern gears		
	8	Case study and simulation		
<b>Practical</b>				
<b>USACMSC5P1</b>		Practicals based on course USACMSC5P1	2	4

**Semester VI**  
**Production and Management**

Theory (Any four units to be opted)				
Course	Unit	TOPIC	Credits	L/Week
<b>USACMSC501</b>	1	Introduction to commercial culture	2	4
	2	Marine value added product		
	3	Introduction to quality control, preservation and processing		
	4	Fish pathology		
	5	New avenues		
	6	Financial management		
	7	Marketing		
	8	Open unit		
<b>Practical</b>				
<b>USACMSC5P1</b>		Practicals based on course USACMSC6P1	2	4

**Semester V: Theory**  
**Oceanography & Capture Fisheries**  
**Course code: USACMSC501**  
(Any four units to be opted)

Lectures 60  
Credits 02

**Unit 1: Zonation of the Sea and Marine Biodiversity**

**Objective:** *To make learner get idea of geological distribution of sea and its relation to biodiversity.*

**Desired outcome:** *Learner would understand different zones of sea (marine habitat) and their impact on biodiversity.*

- 1.1 Zonation of the Sea –Vertical and Horizontal
- 1.2 a) Plankton classification and adaptations  
b) Nekton adaptations
- 1.3 **Benthic adaptations** (two examples of each group)
  - a) Inter-tidal organisms (rocky, muddy & sandy shores)
  - b) Deep sea organisms

**Unit 2: Physical oceanography and ocean related climatic changes**

**Objective:** *To make learner understand different physical factors of ocean and their role in bringing out climatic changes.*

**Desired outcome:** *Learner will get to know physical factors of ocean during different climate and their effect on marine organisms.*

- 2.1 Physical parameters of the sea
  - a) Density
  - b) Illumination
  - c) Temperature
  - d) Pressure
- 2.2 Influence of the following water movements in sea
  - a) Currents – wind driven and thermohaline circulation
  - b) Types of waves (including Tsunami)
  - c) Tides
- 2.3 Influence of the following climatic phenomena
  - a) Monsoon
  - b) Cyclone (including Phyan)
  - c) El Nino

**Unit 3: Chemical oceanography**

**Objective:** *To give learner an idea of normal chemical constituents of sea water and their importance to marine ecosystem.*

**Desired outcome:** *Learner will understand normal values of different chemical nutrients of sea water and their importance for the flora and fauna.*

3.1 Parameters of the sea water

- a) Salinity
- b) pH
- c) Dissolved gases (oxygen and carbon dioxide)

3.2 Nutrients in sea water

- a) Minor constituents (nitrates, phosphates and silicates)
- b) Dissolved organic matter

**Unit 4: Oceanographic instruments**

**Objective:** *To orient learner about different oceanographic instruments, their design, mode of working and analysis of result using them.*

**Desired outcome:** *Learner will come to know about important modern instruments used in the field of oceanography and different chemical, physical and biological parameters studied by using them.*

4.1 Instruments used for marine biological sampling

- a) Niskin water samplers
- b) Dredge and Petersen Grab
- c) Corer
- d) Plankton net (Typical plankton net, Hensen net & Indian Ocean standard net)

4.2 Instruments used for measurement of physical factors

- a) Protected and unprotected reversing thermometer
- b) Current meter
- c) Secchi disc
- d) Echosounder
- e) Wave recorder
- f) CTD (Conductivity, temperature and depth)

4.3 Introduction to fish finding equipments and methods

- a) GPS
- b) SONAR
- c) Remote sensing and satellite oceanography

**Unit 5: Sustainable fishery**

**Objective:** *To educate learner about declining marine fish landings, different rules and regulations for sustainable fishery.*

**Desired outcome:** *To educate learner about declining marine fish landings, different rules and regulations for sustainable fishery.*

5.1 Fishery acts and monitoring bodies

5.2 Remote sensing and forecasting

5.3 Time series analysis, understanding trend for forecasting

**Unit 6: Deep-Sea Fishing vessels and Research Vessels**

**Objective:** *To expose learner to research vessels, deep sea fishing vessels and the advancement in oceanographic research.*



**Desired outcome:** *Learner will understand recent trends in oceanographic research which will motivate them to become budding scientist of tomorrow.*

- 6.1 ORV Sinddhu Sadhana
- 6.2 ORV Sinddhu Sankalp
- 6.3 ORV Sagar Nidhi,
- 6.4 FORV Sagar Sampada

#### **Unit 7: Mechanized boat and modern gears**

**Objective:** *To introduce learner to boat building, its maintenance and operation of fishing gears.*

**Desired outcome:** *Learner will gain knowledge of boat building, its maintenance and operational methods of gears to optimise fish catch.*

- 7.1 Boat design, building and maintenance
- 7.2 Engines – 2 stroke and 4 stroke
- 7.3 Purse seine, Drag net (shore seine), Hooks and Lines, Squid jigs, Tuna long line, Pelagic and Bottom Trawls.

#### **Unit 8: Case study and Simulation**

Case Study and Simulation is one of the eight units and hence may or may not be opted by the college. If opted, teachers in consultation with the students shall select the case studies for this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the case studies and simulations shall be operational and available in the syllabus only till it comes under the scope of internal assessment.

**Objective:** 1. *To encourage abilities of learner to better understand the concepts.*  
2. *To develop better analytical abilities to assess varying dimensions while making decisions.*

**Desired outcome:** 1. *Learner will comprehend and develop better acumen so as to, take wise and necessary decisions while participating in environment related projects or framing policies/assessing environmental damages/carrying out entrepreneurial activities beneficial to environment.*

2. *Learner shall primarily learn to tackle real life situations with common sense.*

**(Any eight from suggested below or more, developed by teacher)**

- 1. Pirotan island marine park
- 2. Challenger expedition
- 3. Indian ocean expedition
- 4. Antarctica expedition
- 5. Destruction of Mangrove along western coastline of Mumbai
- 6. Chartered vessel scheme for technology transfer

7. Ban on exports due to *Salmonella* contamination in 1990's, a lack of sanitary facilities on board
8. Mithi river and Mahim creek: yesterday, today and tomorrow
9. Trilok Foods DST Entrepreneurship model of Public Private Partnership developed through incubation model
10. Tsunami at Andamans.
11. Minamata bay incident – biomagnifications

**Semester V: Practical**  
**Course code: USACMSC5P1**

**02 Credits**

1. **Chemical analysis of sea water:** Silicates, Phosphates, pH and Salinity
2. **Study of oceanographic instruments:**
  - Niskin Water Sampler
  - Van-Veen Grab
  - Reversing Thermometer
  - Current Meter
  - SecchiDisc
  - Standard Plankton Net
  - Echosounder
  - Corer
3. **Ecological adaptations: Intertidal animals**
  - Porifera: Sponge (Sycon)
  - Coelenterata: Sea anemone, Coral, Jelly fish
  - Annelida: *Nereis*, *Arenicola*
  - Arthropoda: *Balanus*, Hermit Crab
  - Mollusca: Oyster, *Mytilus*, *Sepia*, *Loligo*, *Teredo*
  - Echinodermata: Starfish, Sea urchin
  - Coral fish: Clown Triggerfish, Queen Angelfish
  - Deep Sea Animals: Solefish (*Psettodes* and *Cynoglossus*), Angler Fish
4. **Study of zooplanktons:** (Any ten)
5. **Endangered marine species:** Identification and reason for decline of Salmon, Sturgeon, Sea-lion, Seal and Whale
6. Identification and operation of traditional crafts and gear.
7. Photographic documentation of Marine Science related issues.  
Submission of soft & hard copy of 5 original photographs taken by the learner (Exif details required)
8. Assignment (may be submitted in a group not exceeding three students).  
**Please refer to Annexure- I for suggested topics for assignment.**

\*Note- The practical may be conducted by using specimens authorised by the wild life and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/ models etc. as recommended by the UGC and as envisaged in the regulation of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of

conducting practical mentioned here-in above.

N.B

:

- I It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).
- II Apart from the institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority/Body from time to time, every college should constitute the following Committees:
  1. A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
  2. A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

**Composition of DMC shall be as follows:**

- i) Head of the Concerned Department (Convener/Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
- iv) One or two members of related department from neighbouring colleges.

**USE OF ANIMALS FOR ANY EXPERIMENT /DISSECTION /MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.**

**Semester VI: Theory**  
**Production and Management**  
**Course code: USACMSC601**  
(Any four units to be opted)

Lectures60  
Credits02

**Unit 1: Introduction to commercial aquaculture**

**Objective:** *To make learner acquire in-depth knowledge about marine aquaculture of commercially important fishes and prawn.*

**Desired outcome:** *Learner will take the first step to become entrepreneur in the field of culture fishery with basic knowledge of marine aquaculture.*

- 1.1 Brackish water aquaculture of *Litopenaeus vannamei* (Pacific White Shrimp)
- 1.2 *Lates calcarifer* (Asian Sea Bass) culture in race ways.
- 1.3 Cage farming of *Rachycentron canadum* (Cobia)

**Unit 2: Marine value added products**

**Objective:** *To give learner an overview of value added products from marine organisms.*

**Desired outcome:** *Learner will be acquainted with variety of marine value added products, their nutritional values and economic significance.*

- 2.1 Fish protein concentrate, fish maws, isinglass, oils (body and liver), chitin, chitosan, Fish/ Prawn pickle and chutney, fish wafers, surimi, imitation products.

**Unit 3: Introduction to quality control, preservation and processing**

**Objective:** *To make learner understand different methods of preservation and processing of marine products for maintaining its nutritional quality.*

**Desired outcome:** *Learner will acquire knowledge of specific methods of preservation and processing for different fish products for enhancing their shelf life and commercial value.*

- 3.1 Methods of evaluating freshness and quality of fish and prawn. (Organoleptic, Microbial and Chemical)
- 3.2 Mechanisms of spoilage (Hyperemia, *rigor mortis*, Autolysis, Rancidity)
- 3.3 Methods of preservation– Icing, Drying, Salting, Canning, Pickling, Freezing

**Unit 4: Fish pathology**

**Objective:** *To acquaint learner to fish diseases, causative agents, prevention techniques and treatment.*

**Desired outcome:** *Learner will gain expertise to identify causative agents, symptoms and treatment for different fish diseases.*

- 4.1 Fish diseases caused by:
  - a) Protozoan
  - b) Bacteria

- c) Fungi
- d) Worms
- e) Crustaceans
- f) Non parasitic diseases
- g) Fish tumour

4.2 Symptoms and Treatment of the above Diseases

4.3 Prevention techniques: Crop Rotation, Immune Stimulants, Genetic Improvement.

### **Unit 5: New avenues**

**Objective:** *To expose learner to the new avenues in the field of oceanography*

**Desired outcome:** *The learner will become aware of new trends of oceanography which would make them expert in exploiting these opportunities to become successful entrepreneur.*

#### 5.1 Bioactive Compounds

- a) Sea as treasure house of new chemicals
- b) Bioactive metabolites from sponges and bacteria
- c) Bioactive toxins and eutrophication
- d) Bioactive compounds as marine drugs from Demospongiae, Actinobacteria and *Conus*.

#### 5.2 Sea weeds

- a) Classification and Distribution of Seaweeds
- b) Commercial uses of sea weeds as food: Nori (*Porphyra*), Kombu (*Laminaria*), Arame (*Eisenia*), Dulse (*Palmaria*)
- c) Liquid Seaweed Fertilizer
- d) Sea weed as source of Bio-fuel

### **Unit 6: Financial management**

**Objective:** *To make learner aware of different funding schemes for fishery and basics of financial management.*

**Desired outcome:** *Learner will be equipped with knowledge on various schemes available for obtaining finance from different government and semi government agencies and financial management.*

#### 6.1 Procuring finance

- a) Financial Institutions and Funding Agencies
- b) Schemes and subsidies

6.2 Financial Management: Costing, Budgeting, Fund flow, Auditing and Preparation of Feasibility Report.

6.3 Role of NABARD for refinancing and NFDB (National Fishery Development Board, Hyderabad) for funding through State Board.

### **Unit 7: Marketing**

**Objective:** *To provide learner with information on fishery marketing in local, national and international level.*

**Desired outcome:** *Learner will gain knowledge on working of fishery markets and exports.*

- 7.1 Basic concepts of Micro and Macro marketing of fish product.
- 7.2 Traditional Marketing vis-à-vis Operations of Fishery Co-operatives (Sasoon, Karanja, Satpati model)
- 7.3 Global Marketing
- 7.4 Export and Import Procedures

#### **Unit 8: Open unit**

Open unit is one of the eight units which may or may not be opted by the college. Teachers in consultation with the students shall define syllabus under this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the open unit shall be operational and available in the syllabus only till it comes under the scope of internal assessment.

#### **Objective:**

1. *To teach any one of the units prescribed in the syllabus with more details and in depth leading to specialization in the capsule of units selected.*
2. *To incorporate the topics of special need of the area which are otherwise not covered in the syllabus.*
3. *To give scope to creativity and wisdom of a teacher who wants to deal with the latest developments in the subject without waiting for the university to revise the syllabus.*

**Semester VI: Practical  
Marine Science  
Course code: USACMSC6P1**

**Credits02**

1. a) Estimation of primary productivity  
b) Estimation of Biological Oxygen Demand (BOD)
2. Identification of Common edible marine fauna:
  - a) Fish: *Polynemus* spp, *Lates calcarifer*, *Pampus argenteus*, *Formio niger*, *Rastrelliger kanagurta*, *Cybium guttatum*, *Harpodon nehereus*, *Sardinella longiceps*
  - b) Molluscs: Oyster, *Sepia*, *Loligo*
  - c) Crustaceans: Shrimp, Lobster, Crab
3. Identification of molluscan shells: *Trochus*, *Umbonium*, *Oliva*, *Conus*, Conch shell, *Telescopium*, *Mytilus*, *Donax*, *Katelysia*.
4. Determining feeding habits of fish from jaws and gills.
5. Identification of common marine algae: *Ulva*, *Sargassum*, *Padina*, *Fucus*, *Polysiphonia*, *Laminaria*.
6. Fish diseases: Identification from photograph / specimen.
7. Identification of foraminiferan shells
8. Visit to any of the research institutes, fishery industry, landing centres, boat building industry, research vessel, fish market, fishery co-operative societies, funding agencies office and processing units and submission of report.
9. Project and submission of report (Project report may be submitted in a group not exceeding three students).

**Please refer to Annexure- II for suggested Field Visits and Annexure III for suggested topics for projects for Course code USACMSC6P1.**

**\*Note- The practicals may be conducted by using preserved specimens / permanent slides authorized by the wild life and such other regulating bodies though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/models etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.**

**N.B:**

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

- 1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and
- 2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

**Composition of DMC shall be as follows:**

- i) Head of the Concerned Department (Convener / Chairperson)
- ii) Two Senior Faculty Members of the concerned Department
- iii) One Faculty of related department from the same College
- iv) One or two members of related department from neighbouring colleges.

**USE OF ANIMALS FOR ANY EXPERIMENT /DISSECTION /MOUNTING IS BANNED. SIMULATIONS, AUTHORISED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.**



## References and additional reading

### USACMSC501 & USACMSC601

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2. Biology of intertidal animals - Newell, R.C., Lagos Press.
3. Crafts and Gear of India– Y. Shrikrishna & Latha Shenoy – ICAR Publication
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5. Ecological Methods for Field and Laboratory Investigations – P.Michael. •Course Material in Fishing Technology – LathaShenoy, CIFE, Versova, Mumbai.
6. Elementary Statistics - Yule & Kendell, Charless Griffin & Co. London.
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8. Fisheries Bioeconomics – Theory, Modeling and Management – FAO Fisheries Technical Paper 368 – FAO, 2001.
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10. Financial Management – Prasanna Chandra, 7<sup>th</sup> Edition.
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13. Fish and fisheries of India, Jhingran J.S. Hindustan Publication.
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22. Marine Fisheries of India – D.V. Bal and K.V. Rao, Tata McGraw – Hill Publishing Co. Ltd., New Delhi.
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24. Marketing Management – Philip Kotler.
25. Operations Research Theory and Application, Third edition, Sharma J. K.: Macmillan India Ltd.
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27. Prawn and Prawn Fisheries – Kurian & Sebastian.
28. Project Management – Prasanna Chandra.
29. Refrigeration by Arora.
30. Textbook of Marine Pollution - Prakesh P.
31. The Oceans – Svedrup, H.V. et al, Asian Publishing House.
32. The Book of Indian Shells – Deepak Apte, Oxford University Press.

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33. Text book of fish biology and Indian Fisheries by Dr. R.P. Parihar, Central Publication House, Allhabad.
34. Understanding The Sea – Dr. B.F. Chhapgar, Oxford University Press.
35. Wealth of India: Vol. 4 CSIR Publication.

For additional and latest information on the topics, various websites can be visited.

**SCHEME OF EXAMINATION (THEORY & PRACTICAL)**

- a) Internal assessment of twenty five (25) marks per course per semester should be conducted according to the guidelines given by University of Mumbai vide circular number UG/04 of 2014 Dated 5th June 2014 to be implemented from academic year 2014-15.
- b) External assessment of seventy five (75) marks per course per semester should be conducted as per the following skeleton question paper pattern.
- c) One practical examination of one hundred (100) marks per course each should be conducted at the end of every semester.

**Modality of Assessment:**  
**Theory Examination Pattern:**

<b>A)</b>	<b>Internal Assessment (Theory)</b>	<b>25Marks</b>	<b>25%</b>
<b>B)</b>	<b>External examination</b>	<b>75 Marks</b>	<b>75%</b>

<b>A)</b>	<b>Internal Assessment (Theory)</b>	<b>25Marks</b>	<b>25%</b>
<b>Sr. No.</b>	<b>Evaluation type</b>	<b>Marks</b>	
<b>1.</b>	Class test to be conducted as per following pattern	<b>20</b>	
	<b>a.</b> Match the column/Fill in the blanks/Multiple Choice Questions(1/2 mark each)	<b>05</b>	
	<b>b.</b> Answer in 1 or 2 lines(Concept based questions) (1 mark each)	<b>05</b>	
	<b>c.</b> Answer in brief (Attempt any 2 out of the 3) (5 marks each)	<b>10</b>	
<b>2.</b>	Overall conduct as a responsible student, manners, attentive and inquisitiveness skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	<b>05</b>	

**B) External examination 75 Marks 75%**

1. Duration: The examination shall be of two and half hours duration.
2. Theory question paper pattern:
  - a. Q. 1 shall comprises 16 short notes (14 if case studies/open unit is not opted) representing all the units in the syllabus equally, of which students are expected to solve any five.
  - b. Q.2 to Q.9 (Q. 8 if case studies/ open unit are not opted) will be based on unit I to unit VIII of the syllabus respectively.
  - c. Q.2 to Q.9 (Q. 8 if case studies/ open unit are not opted) shall have the following pattern.

**Q. No.**    **A)**            15 Marks

**OR**

**B)** 1.        07 Marks  
      2.        08 Marks

**Practical skeleton paper**  
**Course code : USACMSC5P1**

**Duration : 04 Hrs.**

**Marks: 100**

- Q.1** Identification **20**  
Identify spots 'a' to 'e' as per instructions
- a & b Identify and describe the given instrument  
c & d Identify and describe with reference to ecological adaptations of intertidal organisms.  
e. Identify and describe the endangered marine organism and give reasons of its decline.
- Q.2** Estimation of silicates from sea water. **25**  
**OR**
- Q.2** Estimation of phosphates from sea water. **25**
- Q.3** Estimation of pH of sea water. **15**  
**OR**
- Q.3** Estimation of salinity of sea water. **15**  
**OR**
- Q.3** Identify and comment on features of zooplankton. (Any five) **15**
- Q.4** **a.** Submission of five original photographs of different seashore, crafts (boats), gears, marine organisms, sea weeds, etc. **10**  
**b.** Submission of assignment and viva based on it. **20**
- Q.5** Certified journal. **10**

**Practical skeleton paper**  
**Course code : USACMSC6P1**

**Duration : 04 Hrs.**

**Marks: 100**

- Identification **20**
- Q.1** Identify spots 'a' to 'e' as per instructions.  
a & b Identify and describe the given fish.  
c Identify and describe the given Mollusc  
d Identify and describe the given Crustacean  
e Identify and describe the given shell / alga
- Q.2** Estimation of primary production. **25**
- OR**
- Q.2** Estimation of Biological Oxygen Demand (BOD) from given water sample. **25**
- Q.3** Identify and draw foraminiferan shells.(Any three) **15**
- OR**
- Q.3** Identify and comment on fish diseases and their remedial measures. (Any three) **15**
- Q.4** Project report and Viva based on it. **20**
- Q.5** Field report. **10**
- Q.6** Certified journal. **10**

**ANNEXURES**

**ANNEXURE – I                      Suggested topics for assignment USACMSC5P1**

(Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students)

1. Survey of frozen marine fish products on shelf in malls.
2. Survey of ready to eat fish food products on shelf in malls
3. Survey of ready to cook fish food products on shelf in malls.
4. Survey of prices of Marine Aquarium fishes
5. Survey of types and prices of Live Marine Aquarium fish food
6. Survey of types and prices of Marine Aquarium plants
7. Survey and listing of fishes and their prices from local market.
8. Survey of various aquarium equipments and their prices
9. Survey of fish by-products in cosmetic industry
10. Survey of fish by-products in pharmaceutical industry.

**All topics mentioned above are suggestive, more creative and innovative topics are expected from the students, under the able guidance of the concerned teacher, to suit the expertise, human resources, infrastructure and local needs as also the interest of the students.**

**The assignment may be submitted in a group not exceeding three students.**

**ANNEXURE – II Suggested Field Visits USACMSC6P1**

- There shall be various short and long excursions / study tours / field visits / industrial visits in every semester, at least one of which shall be financially affordable to every student in the class; and that assessment and marks of field trips shall be solely based upon such where no student was restrained for financial limitations.
- Field visits are to be organized to facilitate students to have firsthand experience & exposure to technology/production/functioning of organization/units or witness a relevant activity.
- Each student must make at least 01 (one) such visit to the units/treatment plants/aquatic or terrestrial habitat organized by the College.
- The list is suggestive and not exhaustive.

1. Visit to net manufacturing industry
2. Visit to boat building industry
3. Visit to fish preservation/ processing industries
4. Visit to local fish markets
5. Visit to fish landing centre
6. Visit to shore for studying important intertidal organisms
7. Visit to research institutes
8. Visit to Government and Semi-Government organizations like fishery departments, MPEDA and financial institutions
9. Visit to hatcheries and/or farms
10. Visit to fishery co- operative societies

**ANNEXURE – III Suggested Topics for Projects USACMSC6P1**

**(Teachers are expected to develop additional innovative topics, varying every year, to be assigned to the students)**

1. Prepare feasibility report for setting up an aquarium shop on small/large scale.
2. Prepare feasibility report for setting up an industry for manufacturing any one or more fish by-products.
3. Prepare feasibility report for setting up a fish culture unit.
4. Prepare feasibility report for building up a prawn culture unit.
5. Prepare feasibility report for various aspects of cold storage.
6. Prepare feasibility report for fish preservation unit.
7. Study of seasonal variation in nutrient content of marine water of any coast (silicates, phosphates, nitrates).
8. Analysis of marine water samples collected from different beaches.  
(DO/BOD/COD/Salinity/pH)
9. Study of Mangroves of coastal region.

**The project may be submitted in a group not exceeding three students.**



**ANNEXURE – IV Learners' space**

When education system today has identified special needs of slow learners we are still silent about needs of high IQ students. Teachers are therefore recommended to identify and encourage such students to undertake research with a view to publish paper/s in peer reviewed International Indexed Journals with high impact factor thus providing 'learners' space'.

Some of the suggestive avenues are listed below which can certainly be not exhaustive since the said students under the guidance of teachers can identify latest areas of research. Needless to say that 'learners' space' is optional additional activity which may not be undertaken by college if not befitting.

1. Developing statistical model for forecasting fish landing of prominent fishes.
2. Undertaking physicochemical oceanographic research at the established centres in the deep sea preferably in collaboration with reputed research institutes.
3. Working on qualitative and quantitative analysis of plankton yielding to calculation of indices.
4. Addressing issues of marine oil pollution.

**ANNEXURE – V      Play and Ponder**

While learners' space is for high IQ Students, play and ponder could be a general activity creating interest in the subject and could also be a part of pedagogy wherein it may be considered as innovative teaching methodology. Needless to say that 'play and ponder' again is not mandatory and is an additional activity if desired by the students.

Following are some of the suggestive activities though, of course, teachers can creatively develop more in the years to come.

1. Knitting/ Preparing different fishery gear (nets).
2. Making models of different fishing crafts (boats) using biodegradable materials.
3. Preparation of marketable Prawn pickle and fish pickle and obtaining feedback from 10 students and 5 teachers.

**MODEL QUESTION PAPER USACMSC501**

**Duration**  
**2.5 Hrs.**  
**N.B.**

**Marks**  
**75**

1. Question no.1 is compulsory.
2. Attempt any **four** questions from question no.2 to 9.
3. Draw neat labeled diagrams wherever necessary.

**Q.1** Write short notes on: **Any five** of the following (Mixed questions from all units) **15**

- a) Vertical zonation
- b) Benthic adaptations
- c) Effect of temperature on marine organisms
- d) Effect of pressure on marine organisms
- e) Effect of tides
- f) Effect of salinity
- g) Niskin water sampler
- h) Secchi disc
- i) Mechanism of fishing, boat maintenance
- j) Purse seine
- k) Drag net
- l) Two stroke engine
- m) Dredge
- n) Wave recorder
- o) -----(from Case study, if opted)
- p) -----(from Case study, if opted)

**Q.2 (Unit 1)** Explain vertical zonation of the sea. **15**

**OR**

**Q.2 (Unit 1)**

- a. Give an account of intertidal organisms with reference to muddy shore. **08**
- b. Give an account of benthic adaptations of deep sea organisms **07**

**Q.3 (Unit 2)** Explain the effect of physical parameter of the sea with reference to density. **15**

**OR**

**Q.3 (Unit 2)**

- a. Give an account of wind driven and thermohaline circulation. **07**
- b. Explain types of waves. **08**

<b>Q.4 (Unit 3)</b>	Give an account of effect of the chemical parameter of the sea water with reference to salinity.	<b>15</b>
<b>OR</b>		
<b>Q.4 (Unit 3)</b>	a. Explain impact of dissolved oxygen in the sea water.	<b>07</b>
	b. Give an account of dissolved organic matter in the sea water.	<b>08</b>
<b>Q.5 (Unit 4)</b>	Describe Niskin water sampler.	<b>15</b>
<b>OR</b>		
<b>Q.5 (Unit 4)</b>	a. Describe protected and unprotected reversing thermometer.	<b>07</b>
	b. Describe Sonar used as fishing methods with reference to location and harvesting.	<b>08</b>
<b>Q.6 (Unit 5)</b>	Give an account of fishery acts for sustainable fishery.	<b>15</b>
<b>OR</b>		
<b>Q.6 (Unit 5)</b>	a. Explain different monitoring bodies for sustainable fishery.	<b>08</b>
	b. Describe components of time series and state its models.	<b>07</b>
<b>Q.7 (Unit 6)</b>	Give an account of any one deep sea fishing vessel.	<b>15</b>
<b>OR</b>		
<b>Q.7 (Unit 6)</b>	a. Give an account of any one deep sea research vessel.	<b>08</b>
	b. Give an account of deep sea research fishing vessel with reference to ORV Sinddhu Sankalp.	<b>07</b>
<b>Q.8 (Unit 7)</b>	Explain mechanism of boat building and maintenance.	<b>15</b>
<b>OR</b>		
<b>Q.8 (Unit 7)</b>	a. Give an account of two stroke engine used in fishing crafts.	<b>08</b>
	b. Describe purse seine and drag net.	<b>07</b>
<b>Q.9 (Unit 8)</b>	Case study/simulation ( if opted)	

**Case Study: Trilok Foods DST Entrepreneurship model of Public Private Partnership developed through incubation model**

Gaurang Kotnis, a student of Agricultural University, Rahuri, approached Mr. Vinayak Dalvie for inplant training. To judge his abilities he was given an assignment of finding out information on Surimi. Mr. Dalvie noticed a spark of an entrepreneur in him in the process. Gaurang after, graduating in agriculture with merit failed to seek a seat in post-graduation

in the institute of his choice and approached Mr. Dalvie again for guidance. He was discouraged to do post-graduation but advised to start some business. Gaurang started distributorship of ready to cook food products and achieved some success in it. Mr. Dalvie now advised him to do M.Sc. by research along with his business. Gaurang got registered under his guide ship in SVKM's Mithibai College, with registration No. 39, dated 12.03.2012 in the subject of Zoology with title as "Value addition in *Penaeus monodon* through processed shelf – stable RTE Malvani prawn Pilaf in retort pouch". To begin with Gaurang did work with fresh water prawn as it is available fresh in Satara. Teachers from Hospitality Management colleges and chefs were interviewed for recipe. Blind product testing was done to establish authenticity of Malvani taste.

After a series of trial and error self-stable Prawn pulav was developed in retort packing with a guaranteed freshness for six months without refrigeration with no preservatives added. It was one of the very few fish products available in ready to eat series overcoming susceptibility of prawn to perish fast. This innovative product fetched attention of technocrats and Department of Science and Technology which under the scheme of Public Private Partnership granted an aid of Rs. 3.2 million. Gaurang obtained loan of Rs.5 million from Bank of India and after investing his own shares of Rs. 2.5 million established a unit of RTE at Satara of Maharashtra state.

Today Gaurang is a young food technologist, budding entrepreneur and owner of Trilok Foods India but still neither reached breakeven point in his business nor achieved post-graduation degree. He has established a food processing plant in half an acre of land with built up area of 5000 sq. feet at Satara district of Maharashtra. There are 10 employees at present and more will be employed in future. The Plant has retort sterilizer machine with capacity of 150 kg per batch and can process about one ton of raw material every day. He has produced about 24 different types of Ready to Eat products in having more than six months shelf-life without refrigeration.

The Plant is set up under public private partnership (PPP) model in collaboration with ICT with total cost is INR 11.5 million, out of which grant in aid received from DST is INR 3.2 million, subsidy of INR 1.3 million is expected from ministry of food processing industries, INR 5 million was loan sanctioned under collateral free scheme and INR 2.0 million is SME's investment. The plant was inaugurated by Padma vibhushan Shri Anil Kakodkar, Chairperson, of Rajeev Gandhi commission of Science and technology. Gaurang presented his incubation model at the global R & D 2016 event at Vigyan Bhavan, Delhi, in the presence of Hon. Union Cabinet Minister Shree Nitin Gadkari, where it was highly appreciated. His products are tested and approved also in international market and are being exported to UK, Canada and Gulf Countries.

Unfortunately as he started struggling to establish his business, he is not able to pay attention towards his education and is able to complete M.Sc. (By Research) for which he had registered in March 2012. Running a unit at Satara, developing innovative products and marketing globally makes it very difficult for Gaurang to meet his guide in Mithibai College and complete writing of Thesis though his experimental work is finished long before and has come out in the form of product which made him an entrepreneur.

Q.1. Gaurang today has neither reached breakeven point being in gestation period for about 3 years nor does he have post graduate degree, how would you analyze this case while agreeing or disagreeing with the series of decisions taken by him? (05)

Q.2.Which niche market should Gaurang focus on? (05)

Q.3.What strategies should Gaurang adopt to get an early break-even point? (05)

OR

**CASE STUDY: Antarctica Expedition**

Antarctica is an icy continent as large as India and China put together. It is said to have the world's largest oil and gas reserves and its seas are biologically most productive on earth.

The main reason that India sends any expedition to Antarctica almost as a ritual is to retain its 'coveted' status as a consultative member of the Antarctica Treaty. The treaty signed in 1959 by 12 countries including USA, USSR, UK and Antarctica was aimed at preserving Antarctica as an international research laboratory and to use it only for peaceful purposes.

Indian Antarctic expedition commenced in 1981. After operating from ship and temporary shelters for two years, the first permanent research station 'Dakshin Gangotri' was established in 1983 which was abandoned in 1990 as it got buried under snow. Research base Maitri became operational in 1988 and research base Bharati became operational in 2015. Since March 2012 India's expedition is launched annually where in about 100 to 120 members including scientist, engineers, doctors and tradesman are sent in batches between November to January. So far 35 scientific expeditions including a parallel Weddell expedition in 1989 were carried out to Antarctica. Geophysical, geochemical and glaciology as well as shadow bands on solar eclipse research is also carried out by Indian team.

Maitri station is functional round the year and is one of the Global Positioning Systems (GPS) stations contributing to the International database. It has revealed that recovery of ozone depletion does not take place as fast in Antarctica as in Arctic. India is one of the first country to take up magnetometer triangulation experiments at Antarctica, to study the presence and movement of small scale and aerosol current system. About 30 out of 240 new bacterial species discovered so far in Antarctica are by Indian Scientists. Two genes namely t-RNA modification GTPase and aspartate amino transferase have been identified by our biologist as genes required for survival of bacteria at low temperature. Many lipases and proteases useful to biotechnological industry are also identified from here.

The total amount of expenditure incurred both in establishing Dakshin Gangotri, Maitri and Bharati as well as sending periodic expeditions to Antarctica since its inception i.e. from 1981-82 to 2014-15 is Rs. 1473.39 crores.

The sad part now is that when various travel agencies are conducting cruise of about five weeks to Antarctica and fifth Indian Antarctica expedition is set to sail in December, many of the top research institutions have second thoughts about participating in it. NIO Goa, the country's premier oceanographic research organisation is thinking of withdrawing itself from all future Antarctica expedition.

Q. Is it worth spending about 1500 crores on Antarctica expedition by a developing country like India where large amounts of resources are needed for infrastructure development,

socio-economical upliftment, education etc.– (15)

**Note: Questions of the model question paper are not exhaustive, but suggestive, and teachers have liberty to reframe, modify and add other questions as deemed fit.**

**MODEL QUESTION PAPER USACMSC601**

Duration:  
2.5 Hrs.

Marks  
75

N.B.

1. Question no.1 is compulsory.
2. Attempt any **four** questions from question no.2 to 9.
3. Draw neat labeled diagrams wherever necessary.

- Q.1** Write short notes on: Any five of the following (Mixed questions from all units) **15**
- a) Protein concentrate as value added product
  - b) Fish maws as value added product
  - c) Any two challenges of shrimp culture
  - d) Any two challenges of *Lates calcarifer* culture
  - e) Any two methods to test freshness and quality of fish
  - f) Any two methods to test freshness and quality of prawn
  - g) Name the disease, symptoms of fish caused by protozoan
  - h) Name the disease, symptoms of fish caused by fungus
  - i) Name to sea weeds and there distributions
  - j) To bioactive compounds and their importance
  - k) Any two government schemes for financing fishery
  - l) Role of NABARD in fishery financing
  - m) Micro marketing
  - n) Rules for export of fishes  
------(from open unit, if opted)
  - p) -----(from open unit, if opted)

- Q.2** Describe marine prawn culture (*Litopenaeus vannamei*) **15**  
(Unit 1)

**OR**

- Q.2** a Give an account of cage farming of Cobia. **08**  
(Unit 1) b Describe marine culture with reference to *Lates calcarifer*. **07**

- Q.3** Explain fish protein concentrate and isinglass as value added product. **15**  
(Unit 2)

**OR**

- Q.3** a Give an account of chitosan. **07**  
(Unit 2) b Give an account of surimi. **08**

- Q.4** Describe different characters of fish freshness and its quality. **15**  
(Unit 3)

**OR**



<b>Q.4</b> <b>(Unit 3)</b>	<b>a</b> Give an account on prawn freshness and its quality.	<b>07</b>
	<b>b</b> Explain the methods of spoilage: hyperemia and rigor mortis.	<b>08</b>
<b>Q.5</b> <b>(Unit 4)</b>	Describe fish disease caused by protozoans and comment on modes of infection symptoms and treatment.	<b>15</b>
	<b>OR</b>	
<b>Q.5</b> <b>(Unit 4)</b>	<b>a</b> Describe fish disease caused by fungi and comment on its symptoms and treatment.	<b>07</b>
	<b>b</b> Describe fish diseases caused by crustaceans and comment on its symptoms and treatment.	<b>08</b>
<b>Q.6</b> <b>(Unit 5)</b>	Explain types of sea weeds and their properties.	<b>15</b>
	<b>OR</b>	
<b>Q.6</b> <b>(Unit 5)</b>	<b>a</b> Explain important properties of bioactive compounds.	<b>08</b>
	<b>b</b> Give an account on commercial applications of sea weeds.	<b>07</b>
<b>Q.7</b> <b>(Unit 6)</b>	Name financial institutions and funding agencies and describe their schemes as well as basic subsidies for fishery.	<b>15</b>
	<b>OR</b>	
<b>Q.7</b> <b>(Unit 6)</b>	<b>a</b> Prepare feasibility report of cage farming of Cobia.	<b>08</b>
	<b>b</b> Explain costing, budgeting of establishing fish farm.	<b>07</b>
<b>Q.8</b> <b>(Unit 7)</b>	Give an account of traditional marketing with reference to Satpati model.	<b>15</b>
	<b>OR</b>	
<b>Q.8</b> <b>(Unit 7)</b>	<b>a</b> Give an account of micro marketing.	<b>08</b>
	<b>b</b> Explain different export and import procedure of fish.	<b>07</b>
<b>Q.9</b> <b>(Unit 8)</b>	Question based on Open unit, if opted	<b>15</b>
	<b>OR</b>	
<b>Q.9</b> <b>(Unit 8)</b>	<b>a</b>	<b>08</b>
	<b>b</b>	<b>07</b>

**Note: Questions of the model question paper are not exhaustive, but suggestive, and teachers have liberty to reframe, modify and add other questions as deemed fit.**