AC Item No.
XXXXXXXX 2020
Item no.

UNIVERSITY OF MUMBAI

Program: M.Sc.

Course: Zoology

(Oceanography and Fishery Technology)

Syllabus for Semester III & IV

(Choice Based Credit System
with effect from the academic year 2020-21)

M.Sc. Part II (Semester III and Semester IV)
Zoology (Oceanography and Fishery Technology) Syllabus Committee Members

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Chairman,
G. M. Momin Women's College, Bhiwandi
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Semester III

Paper I: Oceanography

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Paper III: Fish Processing Technology

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Paper IV: Fin Fish and Shell Fish Biology

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Semester IV

Paper I: Capture Fisheries

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Paper II: Marine/Brackish water Aquaculture

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Dr. A. K. Reddy Principal Scientist, Division of Aquaculture, Central Institute Fishery Education, Mumbai – 400 061	**Dr. Ajai Singh** Ramchand Kimatram Talreja College of Arts, Science and Commerce, Chatrapati Shivaji Maharaj Chowk, Ulhasnagar – 421 003
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Paper III: Industrial Fisheries

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Dr. Zeenat Surve Maharashtra College, 246-A, Jahangir Boman Behram Marg, Opp. Alexandra Cinema, Nagpada, Mumbai – 400 008	**Mr. Vrushabh Khulatkar** Student, SSS, Kalina

Paper IV: Instrumentation and Presentation of Scientific data

Dr. Nisar Shaikh Convener, G. M. Momin Women's College, Bhiwandi, Dist. Thane, Maharashtra	**Dr. Utkarsha Chavan** Bhavan's Hazarimal Somani College, Chowpatty, Mumbai – 400 007

CONTENTS

PREFACE

The main objective of reconstructing the Post Graduate syllabus of Zoology for Semester III and Semester IV is to provide global level advanced and skill oriented deep knowledge to the stakeholders which is currently needed for their survival. The current research and teaching in Zoology includes diverse aspects with a balance of organismic and reductionist biology. It offers teaching and research programs in the diverse areas, such as, Animal Physiology, Entomology, Fish Biology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Radiation Biology, Reproductive Biology, Endocrinology, Genomics, Metagenomic, Cancer Biology, etc. Our vision is to provide Global Knowledge in education, training & research in the field of Zoology where teaching and research encrust detailed understanding from microbes to human. The broad skills and deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Therefore, the Board of Studies in Zoology aims to impart holistic understanding of Zoology by "redefining Zoology" to students of every age so that they develop interest in Science. It also aims to develop teaching and research programs that have relevance to society and employability. The M.Sc. program is being revised under CBCS scheme of UGC to meet the expectations of students.

To keep all of the above factors in mind, this syllabus was developed by the curriculum committee of Mentors, subject experts from other Universities and dedicated teachers. Their major role was to abridge, grow, augment and give a forward bearing to Zoology taught in undergraduate curriculum, with projections to future requirements. They have successfully completed this colossal task. I congratulate them.

Dr. Deelip L. Bharmal
Chairman Board of Studies in Zoology
University of Mumbai

PREAMBLE

I am extremely happy to present this new syllabus of Semester III and Semester IV to the teachers and students of Post Graduate Course in Zoology of the specializations, Oceanography and Fishery Technology, Entomology, Endocrinology, Animal Physiology and Environmental Science. While constructing the syllabus, the relevant inputs have been considered from Mentors, subject experts from various fields of other Universities, teachers and stakeholders to make it more effective.

An attempt has been made to make post graduate courses competitive and on par with global standards, as per the directives of University Grant Commission for the implementation of choice based credit system. Hence as per the guideline of UGC the present syllabus is made more interesting with new, innovative topics as per need of the current situation of the world and stakeholders.

The M.Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire skills in handling scientific instruments planning and performing in the laboratory and exercising critical judgment, independent thinking and problem solving skills.

The utmost care has been taken to declare the final syllabus well in advance to enable the teachers to make preparations before commencement of the academic year and facilitating students to execute their right to know the details before admissions.

The draft of Syllabus was approved in meeting of the Board of Studies in Zoology held on 10th March 2020, and it was unanimously resolved to implement the revised syllabus of Zoology at M.Sc. Semester-III and IV and make it effective from the Academic Year 2020-2021 after approval from concerned authorities of the University.

The success of this revamped syllabus will depend totally on the enthusiasm and interest shown by the stakeholders.

Dr. Nisar Shaikh
Chairman, M.Sc. Part II
Syllabus Committee

PEDAGOGY

The course **PSZOOCN301, 'Oceanography'** intends developing in learners a comprehensive understanding of the various aspects of general, physical, chemical and biological oceanography. The practical syllabus complements the prescribed theory syllabus emphasizing on experience or field based teaching and learning. Facilitators may avail the use of ICT including video clips, photographs, and other online resources for enhancing the delivery of the topics. Apart from the regular classroom teaching, the multi-dimensional aspects of oceanography could be effectively taught by frequent visits to intertidal zones to study the marine fauna and flora. Similarly, learners can be instructed to collect sea water samples for physicochemical analyses in-situ or in the laboratory. Additionally, visit to institutes involved in marine biology or oceanography research will augment the knowledge of the learners.

PSZOOCN302: The course **'Freshwater Aquaculture'** will help the learner for conceptual understanding of various methods for Freshwater Aquaculture, Aquarium fish maintenance, sustainable Aquaculture and various funding and insurance agencies. For understanding maintenance and management, visit to freshwater aquaculture farm and aquarium should be organized. For practical knowledge, project for aquarium maintenance in laboratory should be assigned to the learners. Guest lectures should be arranged to provide information about various funding and insurance agencies.

PSZOOCN303 is **'Fish Processing Technology'** which deals with preservation, processing, marketing, logistics, infrastructure required for processing of fish and shell fish. It will impart basic knowledge about the recent techniques used worldwide. It is a need of the time to supply best quality of available sea food by maintaining high levels of quality standard. Students will also learn the layouts of various processing industries and skills to start their own business in this area thereby boosting self-employability.

The Course **'The Fin Fish and Shell Fish Biology (PSZOOCN304)'** deals with the study of morphological characters which will enhance the learners' skill in taxonomy. The fish anatomy provides knowledge of mechanisms and structure of the various life processes of fishes. Similarly the locomotion and light producing organs of fishes focus on their behaviour. Mud crab is a sea food preferred by various people. Its study in biology is essential. Care has been taken to make the learners aware of the Biological aspects in this course.

PSZOOCN401 deals with the **'Capture Fisheries of India'.** This paper includes inland, estuarine and marine capture fishery resources of India. These various fisheries include taxonomy, distribution, food and feeding, breeding season, reproduction, crafts and gears used and catch trends of important fishes available on both the coasts of India. It also involves the population dynamics & conservation, problems of overfishing, maximum sustainable yield and maximum economic yield.

PSZOOCN402, 'Brackish and Marine water aquaculture' Paper deals with several aspects of brackish water and marine water aquaculture systems. It describes the cultivation methods and management of marine and brackish water aquaculture systems. Learners will also procure the knowledge of recent developments, disease diagnosis and integrated marine and brackish water aquaculture systems. Field visits, video clips, models can be used for effective learning. The key focus of this unit is to equip the learners with the skills and encourage them towards entrepreneurship and job creation in the field.

In course **PSZOOCN403, 'Industrial Fishery'** the main focus is given on the applied aspects of fishery. This may develop a platform to produce successful fishery entrepreneurs. Keeping this in the mind, the practicals have been designed, so that the learners develop skills and gain relevant knowledge to prepare various fishery products. Visit to fish processing industry, export unit and marketing surveys can be conducted to get first-hand information on packaging and marketing

aspects of fish products and by-products. Assignment based on case studies of fish entrepreneurs, various agribusiness models and feasibility report can be given to develop entrepreneurial skills of the learners.

PSZOOCN404 consists of **'Instrumentation and Presentation of Scientific Data'** which help the students to choose suitable measuring instruments for their applications and understanding of limitations, principles and measurement errors. The students will aware the efficiency of the instruments. Similarly the course also has the unit of presentation of scientific data. Text, tables, and graphs for data and information presentation are very powerful communication tools. They can make scientific report easy to understand, attract and sustain the interest of beneficiary.

Conveners and Committee Members

M. Sc. II Zoology Syllabus
Choice Based Credit System
To be implemented from the Academic Year 2020-2021

Oceanography and Fishery Technology: Semester III						
Course Name and Code	**Unit**	**Topic Headings**	**Credit**	**Lecture/ Week**	**College Assessment Internal**	**University Assessment External**
Paper I: Oceanography						
PSZOOCN301	**1**	General Oceanography	4	1	40	60
	2	Physical Oceanography		1		
	3	Chemical Oceanography		1		
	4	Biological Oceanography		1		
Paper II: Freshwater Aquaculture						
PSZOOCN302	**1**	Principles of Aquaculture	4	1	40	60
	2	Aquarium Fishes and Management		1		
	3	Brooder and Sexual dimorphism in Major carps		1		
	4	Giant freshwater prawn - *Macrobrachium rosenbergii*		1		
Paper III: Fish Processing Technology						
PSZOOCN303	**1**	Hygienic logistics and Infrastructure	4	1	40	60
	2	Traditional fish processing		1		
	3	Modern fish processing		1		
	4	Quality assurance norms and methods		1		
Paper IV: Fin Fish and Shell Fish Biology						
PSZOOCN304	**1**	Morphology of fin fish and shell fish	4	1	40	60
	2	Basic fish anatomy		1		
	3	Locomotion and Light producing organs in fishes		1		
	4	Mud Crab		1		
		Total	**16**	**16**	**160**	**240**
Practicals						
PSZOOCN3P1	Practicals based on PSZOOCN301		2	4	–	50
PSZOOCN3P2	Practicals based on PSZOOCN302		2	4	–	50
PSZOOCN3P3	Practicals based on PSZOOCN303		2	4	–	50
PSZOOCN3P4	Practicals based on PSZOOCN304		2	4	–	50
	Total		**8**	**16**	**–**	**200**
	Grant Total		**24**	**32**	**160**	**440**

Oceanography and Fishery Technology: SEMESTER IV						
Course Name and Code	**Unit**	**Topic Headings**	**Credit**	**Lecture/ Week**	**College Assessment Internal**	**University Assessment External**
Paper I: Capture Fisheries						
PSZOOCN401	**1**	Inland Fisheries resources of India	4	1	40	60
	2	Estuarine fisheries resources of India		1		
	3	Marine capture fisheries resources of India		1		
	4	Population Dynamics and Conservation		1		
Paper II: Brackish and Marine Water Aquaculture						
PSZOOCN402	**1**	Shell fish culture	4	1	40	60
	2	Fin Fish culture		1		
	3	Farm Engineering		1		
	4	Fin Fish and Shell fish Pathology and Health Management		1		
Paper III: Industrial Fishery						
PSZOOCN403	**1**	Value added Products	4	1	40	60
	2	Fish, Shell fish and Seaweed Products and By-products		1		
	3	Packaging Methods for Fish Products and By-products		1		
	4	Entrepreneurship and Marketing		1		
Paper IV: Instrumentation and Presentation of Scientific data						
PSZOOCN404	**1**	Instrumentation	2	1	40	60
	2	Presentation of Scientific data		1		
	3	Project	2	2		
		Total	**16**	**16**	**160**	**240**
Practicals						
PSZOOCN4P1	Practicals based on PSZOOCN401		2	4	–	50
PSZOOCN4P2	Practicals based on PSZOOCN402		2	4	–	50
PSZOOCN4P3	Practicals based on PSZOOCN403		2	4	–	50
PSZOOCN4P4	Practicals based on PSZOOCN404		2	4	–	50
		Total	**8**	**16**	**–**	**200**
		Grant Total	**24**	**32**	**160**	**440**

M. Sc. Part 2: Semester III (Theory)
PAPER 1: PSZOOCN301
OCEANOGRAPHY

Unit 1: General Oceanography **(15 L)**

Objective:

- *To familiarize learners to the background of Oceanography and the recent developments in the Oceanography.*
- *To understand the basic concepts and instrumentation in Oceanography.*

Desired outcome:

- *The learner will be able to understand the history of Oceanography and its current status.*
- *The learner will be aware of various oceanographic sampling techniques.*

1.1 Oceanographic History, Oceanographic Expeditions: Challenger, Indian Ocean and Antarctic
1.2 Oceanic climatology: ENSO, Impact of climate change on marine life
1.3 Typical oceanographic research Vessel, its equipment and Oceanographic laboratories
1.4 Satellite oceanography: Remote sensing satellites and their applications
1.5 Ocean bottom features
  1.5.1 Continental shelf
  1.5.2 Continental slope
  1.5.3 Submarine canyons
  1.5.4 Submarine mountain ranges
  1.5.5 Sea mounds and Guyots
  1.5.6 Oceanic ridges and rises
  1.5.7 Oceanic trenches
  1.5.8 Abyssal floor
1.6 Oceanographic Instruments
  1.6.1 Grabs (Peterson and Van veen) for benthos collection
  1.6.2 Naturalist's dredge
  1.6.3 Trawl – Beam trawl, Otter trawl
  1.6.4 Plankton nets and Continuous plankton sampling system
  1.6.5 Niskin Water Sampler
  1.6.6 CTD instrument / meter
  1.6.7 Stempel's pipette and dilution jar
  1.6.8 Underwater photography
  1.6.9 SCUBA apparatus
  1.6.10 Secchi disk

Unit 2: Physical Oceanography **(15 L)**

Objective:

- *To familiarize learners to the physical processes of Oceans and the Ocean- Atmospheric interactions.*

Desired outcome:

- *The learner will be able to understand the significant physical processes occurring in the oceans and their effects at Local and Global scenario*.

2.1 Sea water
  2.1.1 Physical properties of Sea Water – Distribution of Temperature, Salinity, Density
  2.1.2 Acoustical and Optical characteristics of Sea water
2.2 Waves and Tides

2.2.1 General aspects of Ocean waves, Waves Characteristics, Sea and swell, Deep and Shallow water waves, Storm surges and Tsunamis
2.2.2 Tides and tide generating forces, their causes, variation and types, Tidal currents

2.3 Ocean Circulation
2.3.1 Ekman spiral, Geotropic current, Westward intensification with dynamic topography
2.3.2 Wind induced circulation, Thermohaline circulation and upwelling of water
2.3.3 Types of currents, major currents of the world, Coriolis effect

Unit 3: Chemical Oceanography (15 L)

Objective:

- *To familiarize learners to the chemical properties of the sea water and basics of Chemical Oceanography.*

Desired outcome:

- *The learner will be aware of the chemical properties of the sea water and their significance.*

3.1 Major and minor elements in seawater
3.2 Chlorinity and Salinity: definition and significance, practical salinity scale
3.3 Radioactive nuclides in the sea
3.4 Micronutrients and their role in marine environment (Phosphorus, Nitrogen, Silicon)
3.5 Dissolved gases (other than CO_2) in seawater – Basic concepts: solubility of gases in seawater and Oxygen Minimum Zone (OMZ) in Arabian Sea
3.6 Air – sea gas exchange, processes affecting their distribution
3.7 Dissolved gases (CO_2) in seawater
3.7.1 Carbon dioxide equilibria in seawater
3.7.2 pH, alkalinity and buffering capacity of oceans
3.7.3 Components of CO_2 system in seawater
3.7.4 Percentage composition of inorganic carbon
3.7.5 Calcium carbonate precipitation and dissolution phenomena
3.7.6 Lysocline and carbonate compensation depth
3.8 Mineral resources from the sea:
3.8.1 Deep sea mud oozes and manganese nodules
3.8.2 Oil, gas and sulphur deposits

Unit 4: Biological Oceanography (15 L)

Objective*:*

- *To familiarize learners to the ecology of marine fauna, its significance and sustainable conservation.*

Desired outcome*:*

- *The learner will be able to understand the life under the sea and their interactions with marine environment.*
- *The learner will be aware of the issue of Marine Pollution.*

4.1 Division of marine environment
4.1.1 Intertidal organisms and their zonation
4.1.2 Marine biotic diversity:
a) Plankton
b) Nekton
c) Benthos
4.1.3 Indices of species richness, measuring diversity, models explaining diversity gradient
4.1.4 Benthic communities:
a) Kelp forests

b) Estuaries
c) Formation and Growth of Coral Reefs
d) Ecological Features of Mangrove Swamps

4.2 Deep Sea Ecology
4.2.1 Faunal composition, Species diversity, Food sources, Rates of Biological Processes, Whale Fall Ecosystem
4.2.2 Hydrothermal Vents and Cold seeps:
a) Chemosynthetic production
b) Vent Fauna
c) Shallow Vents and Cold seeps
d) Unique Environmental Features of Sulphide communities

4.3 Human impact on marine Biota
4.3.1 Fisheries impact
4.3.2 Marine Pollutants:
a) Petroleum Hydrocarbons
b) Plastics
c) Heavy Metals
d) Sewage
e) Radioactive Waste
f) Thermal Effluents
g) Noise
4.3.3 Impact on marine environments:
a) Estuaries
b) Mangrove Swamps
c) Coral Reefs

Learners' Space:

1 Law of Seas
2 Maritime Security

PAPER 2: PSZOOCN302
FRESHWATER AQUACULTURE

Unit 1: Principles of Aquaculture **(15 L)**

Objectives

- *To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems.*
- *To focus on provision of basic concepts of farming of aquatic organisms.*
- *To educates students to learn different methods of culture.*

Desired Outcome

- *The learner will acquire knowledge regarding advanced technologies in aquaculture.*

1.1 Basics of aquaculture – definition and scope
1.2 Systems of aquaculture:
  1.2.1 Pond culture
  1.2.2 Pen culture
  1.2.3 Cage culture
  1.2.4 Rope culture
  1.2.5 Running water culture
  1.2.6 Zero water exchange system
  1.2.7 Re-circulatory aquaculture system (RAS)
  1.2.8 Biofloc
1.3 Physical, chemical and biological factors affecting productivity of ponds
1.4 Criteria for selection of candidate species for aquaculture
  1.4.1 Major fin fish candidate species for fresh water aquaculture such as
    a) Indian major carps – Rohu, Catla, Mrigal
    b) Exotic carps – Grass carp, Common carp, Silver carp
    c) Catfishes – Basa, Magur
1.5 Monoculture, polyculture, composite culture and integrated culture systems
1.6 Rearing Practices and its feasibility/economics
  1.6.1 Traditional
  1.6.2 Extensive
  1.6.3 Semi intensive
  1.6.4 Intensive methods
  1.6.5 Sustainable Aquaculture

Unit 2: Aquarium Fishes and Management **(15 L)**

Objectives

- *To gain knowledge regarding setting of fresh water aquarium, behavioural pattern, feeding habits, live food organisms and supplementary diet for ornamental fishes.*

Desired Outcome

- *The learner will gain knowledge about the setting of commercial aquarium.*

2.1 Identification, breeding and maintenance of important ornamental fishes
  2.1.1 Angel
  2.1.2 Danio
  2.1.3 Discus
  2.1.4 Flower horn
  2.1.5 Gourami
  2.1.6 Siamese fighter

2.1.7 Sword tail
2.1.8 Gold fish
2.1.9 Koi

2.2 Setting and design of freshwater aquarium, aeration devices, aeration accessories, various types of filters

2.3 Aquatic plants and other structures for beautification and utility
2.3.1 Amazon sword
2.3.2 Cork screw
2.3.3 Ludwigia
2.3.4 Aqua rose
2.3.5 Cobamba
2.3.6 Pistia
2.3.7 Formulated feed, its composition and its production

Unit 3: Brooder and Sexual dimorphism in Major carps (15 L)

Objective

- *To aware the learners for identification of sexual dimorphism in Major carps and their maturity and spawning.*

Desired Outcome

- *The learner will acquire knowledge regarding sexual dimorphism in Major carps and their maturity and spawning.*

3.1 Induced breeding
3.1.1 History of induced breeding of fishes
3.1.2 Methods of pituitary extract preparation
3.1.3 Dosage determination and injection to the brood fishes
3.1.4 Spawning and hatching
3.1.5 Use of different synthetic hormones and analogues for induced spawning.
3.1.6 Induced breeding in Indian Carps – Catla, Labeo, Mrigal
3.1.7 Induced breeding in Exotic Carps – Common Carp, Silver Carp, Grass Carps

3.2 Hatchery design and operation
3.2.1 Criteria for site selection of hatchery
3.2.2 Design and function of incubators
3.2.3 Essential components of hatchery, Role of hatchery
3.2.4 Management of hatchery
3.2.5 Traditional double-walled hapa, Floating hapa
3.2.6 Types of hatchery
a) Vertical hatchery – Glass jar hatchery, Plastic Bucket hatchery
b) Chinese hatchery
c) Circular hatchery – CIEF D 80 Model and CIEF 81 Model
3.2.7 Mahaseer and Trout hatchery

3.3 Nursery Pond Management
3.3.1 Pre-stocking pond management
3.3.2 Stocking pond management
3.3.3 Post stocking management

3.4 Packaging and Transport.
3.4.1 Quality of container used in packaging and transporting the fish seed
3.4.2 Transport containers for fish and fingerlings
3.4.3 Packing and transportation of fish seed
3.4.4 Use of anaesthetics and disinfectants in fish breeding and transport.

Unit 4: Giant freshwater prawn – *Microbranchium rosenbergii* **(15 L)**

***Objective*:**

- *To aware the learners about the life history and hatchery of Giant Fresh Water Prawn.*

Desired outcome:

- *The learners will familiarize the breeding, hatchery and rearing of the prawn.*

4.1 Identification, sexual dimorphism, selection of brooder
4.2 Breeding and hatchery management
4.3 Life cycle
4.4 Rearing of Fresh water Giant Prawn

Learners' Space:

1. Present scenario of Aquaculture.
2. Role of Aquatic resources in food and nutrition.
3. Role of NABARD and NFDB (National Fisheries Development Board) in fisheries development.

PAPER 3: PSZOOCN303
FISH PROCESSING TECHNOLOGY

Unit 1: Hygienic Handling of fish **(15 L)**

Objectives:

- *To impart knowledge and skill of handling of fish in hygienic conditions at various levels as well as personnel hygiene.*
- *To assess freshness of fish.*
- *To gain knowledge of site selection, building construction and layout of different processing units.*

Desired Outcome:

- *The learner will be able to handle the fish hygienically after sorting the fresh fish.*
- *To gain knowledge of site selection, building construction and layout of different processing units.*

1.1 Methods of handling of fish
1.2 Hygienic conditions required on board, landing centres and processing industry
1.3 Methods of transportation (conventional and recent) of fish to processing industry
1.4 Organoleptic tests
1.5 Temperature modeling and relationships in fish transportation
1.6 Typical layout for freezing industry, ice factory and canning industry
1.7 Site Selection:
  1.7.1 Location
  1.7.2 Site Level
  1.7.3 Communications
  1.7.4 Site size
1.8 Building specifications:
  1.8.1 General introduction
  1.8.2 Doors and windows
  1.8.3 Lighting
  1.8.4 Ventilation
  1.8.5 Drains
  1.8.6 Power supply
  1.8.7 Water supply
  1.8.8 Factory yards

Unit 2: Traditional fish processing **(15 L)**

Objectives*:*

- *To get acquainted with different methods and materials required in traditional fish processing.*

Desired Outcome*:*

- *The learner will understand packaging materials, compression system, refrigerants, freezers, freezing, canning of fish with additional knowledge of additives and instrumentation used in fish processing industry.*

2.1 Indigenous methods of preservation
2.2 Simple Vapour Compression System (Refrigerator):
  2.2.1 Ideal refrigerant,
  2.2.2 Types of refrigerants
2.3 Types of freezers, freezing of fin fishes and shell fishes
2.4 Accessory industry for canning, canning of fin fishes, shell fishes and cephalopods
2.5 Additives in fish processing

2.6 Major equipment used in fish processing industry and its maintenance

Unit 3: Modern fish processing **(15 L)**

***Objectives**:*

- *To give in depth knowledge of recent methods in fish processing.*

Desired Outcome:

- *The learner will gain insight of recent methods in fish processing industry.*

1.1 Surimi technology and surimi based analogue products (only technology aspect)
1.2 Thermal processing of fishery products
  1.2.1 Thermal processing
  1.2.2 Pulsed light technology
  1.2.3 Infra-red (IR) and Radio frequency (RF) processing technology and its applications
  1.2.4 Ohmic or Joule heating
1.3 Non-thermal processing of fishery products
  1.3.1 High pressure processing
  1.3.2 Vacuum cooling
  1.3.3 Irradiation

Unit 4: Quality assurance norms and methods **(15 L)**

***Objectives**:*

- *To give in depth knowledge of recent methods in quality control and their norms.*

***Desired Outcome**:*

- *The learner will gain insight of recent methods in quality control and their norms.*

4.1 Introduction to Quality Assurance
4.2 Microbiological testing:
  4.2.1 Standard norms
  4.2.2 Biogenic amines
  4.2.3 Rapid detection kits
4.3 Hazard Analysis Critical Control Point (HACCP)
4.4 Check list for ensuing sea food safety
4.5 Changes that occur during freezing and frozen storage, and Protective treatments:
  4.5.1 Changes:
    a) Microbiological
    b) Physical and chemical changes
    c) Protein denaturation
    d) Fat oxidation
    e) Dehydration
    f) Drip
  4.5.2 Protective treatments:
    a) Polyphosphate
    b) Glazing
    c) Antioxidants
    d) Packaging
4.6 ISO-9000 series certification of the International Standard Organization
4.7 National and International food laws, integrated food law (FSSAI, CODEX GMP)
4.8 Harbour management
4.9 Fish Toxins – Intrinsic and extrinsic factors for toxicity of fish

Learners' Space:

1. Accessary used in fish processing industry for maintaining hygiene.
2. Work experience in fish processing industry.

PAPER 4: PSZOOCN304
FIN FISH AND SHELL FISH BIOLOGY

Unit 1: Morphology of fin fish and shell fish **(15 L)**

Objective:

- *To familiarize the learners about importance of morphological characters of fin fish and shell fish for taxonomy.*

Desired outcome:

- *The learners will gain the knowledge of morphological characters and will enable to use in the taxonomy of fin fish and shell fish.*

1.1 Fin fish morphology: skin, colour, eyes, mouth structure, jaws and teeth, fins, fin rays, spine, scales, operculum, gills and gill rakers, claspers,
1.2 Shell fish morphology: eyes, hectocotylus arm, foot, shells, tentacles, pleopods, uropods, cehalothoraxic appendages, antennae, antennules, spines
1.3 Morphometric measurement, Significance of morphometric measurement
1.4 Taxonomic importance of morphological characters

Unit 2: Basic fish anatomy **(15 L)**

Objective:

- *The learners will familiarize the basic of fish anatomy.*

Desired outcome:

- *The learners will aware about basic of fish anatomy.*

3.1 Digestive system of a teleost and its associated glands
3.2 Respiratory system
  3.2.1 Gill - Structure and Types, Mechanism of respiration
  3.2.2 Air bladder – Structure and Types, functions
  3.2.3 Accessory Respiratory Organs
  3.2.4 Respiratory pigment
3.3 Nervous system of Teleost
3.4 Sense organs and Endocrine organs in fishes
3.5 Weberian ossicle – Structure and functions
3.6 Heart and aortic arches of a teleost
3.7 Excretion and Osmoregulation:
  3.7.1 Structure and function of the excretory organs
  3.7.2 Major excretory products of fishes, Patterns of nitrogen excretion
  3.7.3 Osmotic and ionic regulation – Acid-base balance

Unit 3: Locomotion and Light producing organs in fishes **(15 L)**

Objective:

- *The learners will familiarize about locomotion and light producing organs.*

Desired outcome:

- *The learners will gain the knowledge of types of locomotion, significance of luminescent and advantages of migration of fishes.*

3.1 Locomotion
  3.1.1 Types of locomotion
  3.1.2 Special mode of locomotion

3.1.3 Locomotion due to the movement of appendages

3.2 Migration in fishes
- 3.2.1 General account of migration
- 3.2.2 Types of migration
- 3.2.3 Advantages of migration
- 3.2.4 Factors influencing migration
- 3.2.5 Symbiosis

3.3 Light producing organs
- 3.3.1 Location
- 3.3.2 Nature of light producing organs
- 3.3.3 Structure of light producing organs
- 3.3.4 Significance of luminescence in fishes

Unit IV: Mud Crab **(15 L)**

Objective:
- *To aware the learners about importance of mud crab.*

Desired outcome:
- *The learners will get the knowledge about biology and importance of the mud crab.*

1.1 Distribution, Habit and Habitat
1.2 External characters
1.3 Life history
1.4 Migration and movement
1.5 Heart and circulatory system
1.6 Respiratory system
1.7 Economic importance

Learners' space:
1. Collect the photographs of various locomotion of fishes
2. Collect the photographs of light producing fishes.

M. Sc. Part 2: Semester III Practical
Practical 1: PSZOOCN3P1: Oceanography

1. Oceanographic instruments:
   a) Niskin water sampler
   b) CTD meter
   c) Bathythermometer
   d) Ekman's Current Meter
   e) Secchi disc
   f) Plankton nets:
      i. Standard net
      ii. Hensen net
      iii. Clarke Bumpus net
   g) Stemple pipette and counting slide
   h) Nekton sampling device:
      i. Beam trawl
      ii. Otter trawl
   i) Benthic sampling devices:
      i. Naturalist dredge
      ii. Scallop dredge
      iii. Petersen grab
      iv. Van veen grab
      v. Ekman grab and corers
2. Physical and chemical oceanography: Determination of physico-chemical parameters:
   a) Salinity (Argentometric method)
   b) Silicates
3. Estimation of primary productivity by light and dark bottle.
4. Identification of Zooplankton permanent slides: *Noctiluca*, *Obelia* medusa, Jelly fish, *Physalia*, *Porpita*, Zoea, Copepods, Mysids, Megalopa, Bipinnaria, Nauplius, Pteropods, *Sagitta*, *Doliolum*, *Oikopleura*, Fish eggs and larvae
5. Laboratory procedure for quantitative estimation of plankton settling method, wet weight method, weight displacement method, counting method.
6. Identification of intertidal organisms:
   a) Rocky shore: *Patella*, *Chiton*, *Pernaviridis*, *Cardium*, *Balanus*, Gorgonids, *Littorina* and Corals (*Acropora, Meandrina, Astraea* / Star coral)
   b) Sandy shore: *Solen, Umbonium, Oliva,* Fiddler crab, Star fish, *Balanoglossus*
   c) Muddy shore: *Lingula, Chaetopterus, Arenicola,* Tubiculus worm, Mud skipper
7. Food and feeding habit in fish.
8. Students Activity: Observation of Molluscan shells and Marine algae during field visit and submit report.
9. Visit to Institutes involved in Marine Biology or Oceanography Research.

Practical 2: PSZOOCN3P2: Freshwater Aquaculture

1. Estimation of Turbidity, DO, pH, Hardness CO2 and BOD of pond water.
2. Identification
   a) Major candidate species of fishes - *Labeo rohita, Catla catla, Cirrhina mrigala, Cyprinus carpio, Ctenopharyngodon idellus, Hypophthalmichthys molitrix*)
   b) Crustaceans - *Macrobrachium rosenbergii*.
3. Identification of important ornamental fishes (Angel, Danio, Discus, Flower horn, Gourami, Siamese fighter, Sword tail, Gold fish, Koi).
4. Identification of important aquatic plants used in aquarium. (Amazon sword, Cork screw, *Ludwigia,* Aqua rose*, Cobamba, Pistia*).
5. Setting up of aquarium and maintenance of aquarium fishes.
6. Study of developmental stages in fish – Eggs, hatchings and fingerlings.
7. Study of various components of fish hatchery.
8. Study of sexual dimorphism in *Macrobrachium rosenbergii*
9. Study of various stages in the life cycle of *Macrobrachium rosenbergii* (Eggs larva, Juvenile)
10. Visit to fresh water hatchery/aquaculture farm and submit a report.

Practical 3: PSZOOCN3P3: Fish Processing Technology

1. Organoleptic tests freshness of fish and fishery products.
2. Dressing (Beheading, Peeling and Deveining) and grading of shrimps.
3. Fish dressing and filleting.
4. Estimation of moisture content in fish and shrimp muscle.
5. Sketching of layout of ice factory, cold storage, freezing and canning industry.
6. Identification of various equipment (Photographs)
   a) Thermal processing
   b) Pulsed light technology
   c) Infra-red (IR) and Radio frequency (RF) processing
   d) Ohmic or Joule heating
   e) High pressure processing
   f) Vacuum cooling
   g) Irradiation
7. Preparation of proposal for fish processing industry.
8. Visit to fish processing industry, fish landing centres, cold storages and ice plants.

Practical 4: PSZOOCN3P4: Fin fish and Shell Fish Biology

1. Identification - *Matuta sp.*, *Scylla serrata*, *Neptunus sanguinolentus*, *Neptunus pelagicus*, *Charybdis sp*., *Sepia sp.*, *Loligo sp*.
2. Dissections
   a) Nervous system of a suitable bony fish
   b) Aortic arches of a suitable bony fish
   c) Digestive system of a suitable bony fish
   d) Weberian ossicles from a suitable bony fish
   e) Heart and circulatory system of mud crab
3. Mountings
   - Fins, Gills and rakers, clasper, hectocotylus arm, rostrum, chelate leg, pleopod, uropod, antenna, antennule, walking leg, air bladder,
4. Types of fins and scales
5. Permanent slides
   - Larval stages of crab,
6. To identify and locate the shoals of fishes from the data/photographs captured by remote sensing devices/techniques/GPS (Demonstration only)
7. Determination of ammonia from the tank water
8. Identification of Air Breathing Fishes – *Anabas testudineus, Clarius batrachus, Boleophthalmus spp*
9. Visit to local fish market to identify commercially important shell fishes and and prepare a report.

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M. Sc. Part 2: Semester IV (Theory)
PAPER 1: PSZOOCN401
CAPTURE FISHERIES

Unit 1: Inland Fishery resources of India **(15 L)**

***Objective**:*

- *To create awareness about the rich diversity of commercially important aquatic resource organisms of inland fisheries and their economic potential.*

***Desired outcome**:*

- *Learners will get a bird eye view on dimension and magnitude of inland fisheries potential of India.*

1.1 Riverine fisheries
  1.1.1 West coast riverine system
  1.1.2 East coast riverine system
  1.1.3 North Eastern riverine system
1.2 Lacustrine fisheries:
  1.2.1 Origin
  1.2.2 Ecology
  1.2.3 Productivity of lakes
1.3 Tropical fisheries:
  1.3.1 Carps
  1.3.2 Cat fishes
1.4 Temperate fisheries:
  1.4.1 Trout
  1.4.2 Mahaseer
1.5 Fishery Resources of Maharashtra
  1.5.1 East coast river system
  1.5.2 North Eastern river system

Unit 2: Estuarine fishery resources of India **(15 L)**

***Objective**:*

- *To create awareness about the rich diversity of commercially important aquatic resource of estuaries and other economic potential.*

***Desired outcome**:*

- *Learners will get knowledge about the specific estuarine resource of India*.

2.1 Ecology of Estuaries
2.2 Principle Fisheries of Brackish water, Fisheries of Chilka, Pulicat and Kolleru lake
2.3 Hooghly Matlah Estuary
2.4 Hilsa fishery, Mullet fishery, Khajuri fishery

Unit 3: Commercially important fisheries in India **(15 L)**

(Taxonomy, Distribution, Food and feeding, Reproduction, Crafts and gears used and catch trends of the following fisheries)

***Objective**:*

- *To create awareness about food and feeding, reproduction and crafts and gears used in fisheries.*

***Desired outcome**:*

- *Learners will get knowledge about the crafts and gears, food and feeding used in fisheries of India*.

3.1 Coastal fisheries
- 3.1.1 Shark – *Scoliodon sorrakowah*
- 3.1.2 Ray – *Himantura uarnak (Trygon uarnak)*
- 3.1.3 Sardine – *Sardinella longiceps*
- 3.1.4 Mackeral – *Rastrelliger kanagurta*
- 3.1.5 Bombay duck – *Harpodon nehereus*
- 3.1.6 Pomfret – *Pampus cinereus (Stromateus cinerius), Pampus chinensis (Stromateus sinensis), Parastromateus niger*
- 3.1.7 Thread fin – *Eleutheronema tetradactylum (Polynemus tetradactylus), Galeoides decadactylus (Polynemus polydactylus)*
- 3.1.8 Pink Perch – *Nemipterus japonicus (Synagris japonicus)*
- 3.1.9 Ribbon fish – *Lepturacanthus savala (Trichiurus savala)*

3.2 Deep Sea fisheries
- 3.2.1 Yellow fin Tuna - *Thunnus albacares*
- 3.2.2 Skipjack Tuna - *Katsuwonus pelamis*

3.3 Commercial Shell fish fisheries
- 3.3.1 Crustacean
  - a) Shrimp – *Litopenaeus vannamei*
  - b) Crab – *Scylla serrata*
  - c) Prawn – *Penaeus monodon*
  - d) Lobster – *Panulirus sp.*
- 3.3.2 Mollusca
  - a) Clam – *Katelysia opima*
  - b) Mussels – *Perna viridis (Mytilus viridis)*
  - c) Oyster – *Crassostrea ingens*
  - d) Cephalopod – *Sepia pharaonis*

Unit 4: Population Dynamics and Conservation (15 L)

***Objective**:*
- *To impart knowledge about conservation and sustainable consumption / harvesting of these depletable natural resources.*

***Desired outcome**:*
- *Learners will appreciate and adapt the principles of sustainability for conservation and long-term sustenance of the capture fisheries*.

4.1 Structure and estimation of population
4.2 Factors affecting fish population
4.3 Problems of overfishing
4.4 Concept of MSY (Maximum Sustainable Yield), MEY (Maximum Economic Yield) and recruitment
4.5 Conservation of capture fisheries resource
4.6 Abundance in population and fishery
4.7 Fishery catches and fluctuation, Optimum Yield, Age Composition, Population Growth, Population Models

Learners' Space:
1. Commercially marine captured fisheries of
   a) Pakistan
   b) Australia
   c) Philippine
2. Blue water economy

PAPER 2: PSZOOCN402
BRACKISH AND MARINE WATER AQUACULTURE

Unit 1: Shell fish culture **(15 L)**

Objective

- *To familiarize the learners about breeding, raising and harvesting of shellfish and aquatic plants.*

Desired outcome

- *The objective is an environmentally responsible source of food and commercial products, helps to create healthier habitats, and is used to rebuild stocks of threatened or endangered species.*

1.1 Crab culture
- 1.1.1 Introduction, History and Present status of crab culture
- 1.1.2 Cultivable species of crabs in India
- 1.1.3 Pond design
- 1.1.4 Principles of crab hatchery, brood stock, larval and post-larval management
- 1.1.5 Techniques of Crabs culture, cage culture and pen culture
- 1.1.6 Crabs fattening
- 1.1.7 Prospect, problems and development of crab culture in India

1.2 Brackish water Prawn – *Penaeus monodon* Culture
- 1.2.1 Breeding techniques
- 1.2.2 Hatchery & Nursery Management
- 1.2.3 Rearing practices – Extensive, Semi-intensive, Intensive & Sustainable

1.3 Pearl oyster culture
- 1.3.1 Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls
- 1.3.2 Pearl culture techniques
  - a) Rafts
  - b) Long lines
  - c) Pearls oyster baskets
  - d) Under water platforms
  - e) Mother oyster culture / Collection of oysters
  - f) Rearing of oysters
  - g) Environmental parameters
  - h) Pearl Oyster surgery
    - i. Selection of Oyster
    - ii. Graft tissue preparation
    - iii. Nucleus insertion
    - iv. Conditioning for surgery
  - i) Post-operative culture, harvesting of pearl, clearing of pearl
  - j) Present status, Economic importance of pearls
  - k) Prospects and problems of pearl industry in India

1.4 Live feed culture
- 1.4.1 Candidate species of phytoplankton and zooplankton as food organisms
- 1.4.2 Tropic potentials- proximate composition of live feed
- 1.4.3 Culture requirements of important live food organisms
- 1.4.4 Culture of Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish

Unit 2: Fin Fish culture **(15 L)**

Objective

- *To familiarize the learners about breeding, raising and harvesting of fin fish.*

Desired outcome

- *The objective is an environmentally responsible source of food and commercial products, helps to create healthier habitats, and is used to rebuild stocks of threatened or endangered species.*

2.1 Lates calcarifer
2.2 Mullet
2.3 Milk fish

Unit 3: Farm Engineering **(15 L)**

Objective

- *To reduce operating costs and maximize the farmer's income.*
- *To develop a more economic ration for fish from wastes to useful fish protein production.*
- *To solve the waste management problem.*
- *To control the pollution problem associated with livestock.*

Desired outcome

- *The employment and economic advantages, as well as the possibility of sustaining species that might be over-fished if not for the controlled environments of fish farms.*

3.1 Design, layout and construction of different aqua farms and aqua house
3.2 Construction and design of pond dyke and sluice gate
3.3 Water supply and drainage system
3.4 Design and fabrication of automatic feeder, aerator and bio filter
3.5 Instruments (Kits) for measuring water quality

Unit 4: Fin Fish and Shell fish Pathology and Health Management **(15 L)**

Objective

- *To undertake surveillance of existing and emerging fish and shellfish diseases.*
- *To develop improved diagnostic techniques for the detection of existing and emerging fish and shellfish diseases.*

Desired outcome

- *The study of fish and shellfish diseases gives a wide knowledge, not only of the potential pathogens, but also of the environmental constraints and specialist adaptations, which govern the ectothermic, aqueous, existence of organisms.*

4.1 Fish Pathology: Causative agents, symptoms and control of some infectious diseases of fish
  4.1.1 Diseases
    a) Fungal Diseases - Saprolegniasis, Branchiomycosis
    b) Bacterial Diseases - Fin and Tail rot, Ulcer diseases, Dropsy, Eye diseases, Ferunculosis, Bacterial Gill diseases, ERM, Edwardsiellosis, Vibriosis
    c) Protozoan Diseases - White spot diseases, Costiasis, Trichodinosis, Whirling disease

d) Metazoans - Dactylogyrus, Gyrodactylus, Hirodinosis, Lernaea, Argulus
e) Viral diseases - IPN, IHN, VHs, CCVD, EUS

4.2 Shell Fish Pathology: Some common diseases of prawns – pathogens, symptoms and control-
  4.2.1 IHNV, Baculovirus, Black gill disease, brown spot disease

4.3 Health Management
  4.3.1 Principles of disease diagnosis
  4.3.2 Epidemiological and clinical diagnosis
  4.3.3 Microbiological and post mortem examination of fin fishes in fresh water, brackish water and marine water environment
  4.3.4 Environmental impact of disease management
  4.3.5 Aquaculture medicines and its importance in fisheries
  4.3.6 Rules and regulation for use of aquaculture medicine

Learners' Space:

1. Recent advances in brackish and marine water aquaculture.
2. Concept of cold water marine aquaculture.

PAPER 3: PSZOOCN403
INDUSTRIAL FISHERY

Unit 1: Value added Products **(15 L)**

Objective

- *To familiarize the learners about the entrepreneur of value added products from the fin fish and shell fish.*

Desired Outcome

- *The learners will get knowledge of value added preparation and will start its own business.*

1.1 Dry, salted and smoked products
1.2 Fish / Prawn Pickle
1.3 Fish Chakli and Wafers
1.4 Artificial products / Crabs streaks
1.5 RTE products
1.6 Fish Kabab
1.7 Fish cuttlet
1.8 Fish Amoti
1.9 Fish Rumani
1.10 Fish fillets

Unit 2: Fish, Shell fish and Seaweed Products and By-products **(15 L)**

Objective

- *To provide information on various fish products and by-products, utilization of fishery wastes and their nutritional value.*

Desired Outcome

- *The learner will develop the competence for making fish by products leading to self-employment.*

2.1 By-products
  2.1.1 Fish meal
  2.1.2 Fish oil
  2.1.3 Fish protein concentrate
  2.1.4 Functional fish protein concentrates
  2.1.5 Isinglass
  2.1.6 Shark leather
  2.1.7 Fish glue
  2.1.8 Fish gelatin
  2.1.9 Pearl essence
  2.1.10 Shark fin soup
2.2 Fermented fish products
  2.2.1 Fish-Shrimp sauces and pastes
  2.2.2 Philippine Bagoong
  2.2.3 Malaysian Budu
  2.2.4 Fish silage
  2.2.5 Fish Protein Hydrolysate
2.3 Products from marine invertebrates shell waste
  2.3.1 Chitin
  2.3.2 Chitosan

2.3.3 Glucosamine hydrochloride
2.3.4 Astaxanthine
2.3.5 Calcium Supplements from shell

2.4 Seaweed products
2.4.1 Alginates
2.4.2 Agar agar
2.4.3 Agarose
2.4.4 Carageenan

Unit 3: Packaging Methods for Fish Products and By-products (15 L)

Objective

- *To impart comprehensive overview of the scientific and technical aspects of food packaging.*

Desired Outcome

- *The learner will be equipped with the knowledge on packaging machinery, systems, testing and regulations of packaging, thus helping in job placement in fish processing / export unit.*

3.1 Food packaging
3.1.1 Purposes of food packaging
3.1.2 Technological aspects of packaging of fishery products
3.1.3 Packing of fresh and frozen fish for consumers
3.1.4 Packaging for transport, shipping and institutional supplies
3.1.5 Packaging standards for domestic and international trade

3.2 Packaging materials
3.2.1 Basic films and laminates, their manufacture and identification
3.2.2 Resistance of packaging materials
3.2.3 Development of protective packaging for fishery products

3.3 Modified atmosphere packaging
3.3.1 Controlled packaging and aseptic packaging
3.3.2 Flexible packing, retort pouch processing of fish and fishery products principles and techniques

3.4 Labelling and printing of packaging materials.
3.4.1 Labeling requirements – national and international, legislation on labeling
3.4.2 Labeling for product traceability
3.4.3 Type of labeling for organic foods, specific foods like organic foods, GM foods, irradiated foods, vegetarian and non-vegetarian foods. Label design specification – size, colour

3.5 Biodegradable plastics, Edible packaging and Bio-composites
3.6 Environmental Concerns: Recycling and Disposal of Plastic waste
3.7 Paper and Paper-based materials, Corrugated Fiber Board box (CFB)

Unit 4: Entrepreneurship and Marketing (15 L)

Objective

- *To familiarize the students with the basic concepts of Entrepreneurship and marketing as applied to fishery industries.*

Desired Outcome

- *The learner will understand and apply the entrepreneurship and marketing skills and become a successful entrepreneur.*

4.1 Role of Government and other organizations in promoting entrepreneurship

4.1.1 Government schemes and incentives for Small and Medium enterprises (SMEs)
4.1.2 Small Scale Industries (SSIs), START Ups, Women entrepreneurs

4.2 Science and Technology in Entrepreneurship Development (STED project of NSTEDB), Agribusiness Incubation Centre (ICAR), National Fisheries Development Board (NFDB), National Bank for Agriculture and Rural Development (NABARD), Entrepreneurship Development Institute of India (EDII), National Co-operative Development Corporation (NCDC), Small Industry Development Organization (SIDO), National Institute for Entrepreneurship and Small Business Development (NIESBUD), National Alliance Young Entrepreneur (NAYE), Self Employed Women Association (SEWA), Self Help Groups (SHGs)

4.3 Fish Market
4.3.1 Structure, Functions and Types
4.3.2 Marketing channels & supply chains
4.3.3 Consumer behaviour
4.3.4 Marketing research

4.4 Fish markets & marketing in India:
4.4.1 Problems of fish marketing in India
4.4.2 Cold storage & other marketing infrastructure in India
4.4.3 Marketing organization and improvement
4.4.4 E-marketing
4.4.5 Role of Government and Co-operatives in fish marketing, Export and import of fish & fishery products, Role of MPEDA

Learners' Space:

1. Food Packaging Laws and Regulations
2. Packaging Machinery

PAPER 4: PSZOOCN404
INSTRUMENTATION AND PRESENTATION OF SCIENTIFIC DATA

Unit 1: Instrumentation **(15 L)**

Objective

- *To learn how to design and build instruments for laboratory measurement.*
- *To understand fundamental principles of operation.*

Desired Outcome

- *The learner will understand methods for operation of instruments and data analysis.*
- *The learner will understand how instrumentation can advance scientific research.*

1.1 Centrifugation:
- Principle and applications of Centrifugation
- Differential and density gradient Centrifugation

1.2 Electrophoresis:
- Principle
- Structural components
- Applications

1.3 Chromatography:
- Principle and applications
- Adsorption
- Ion exchange
- Gel permeation
- Affinity

1.4 Spectrophotometer:
- Principle
- Applications

1.5 pH meter
- Principle
- Applications

1.6 Microscopy
- Binocular
- Trinocular

Unit 2: Presentation of Scientific data **(15 L)**

Objective

- *To aware the students for good practice in data presentation.*
- *To aware the students to use different data presentation formats.*

Desired Outcome

- *The students will familiarize to explain their research data by using different techniques for presenting their scientific data.*

2.1 Types of presentation:

- Oral
- Poster
- Written
- Audio-visual

Aids for presentation

2.2 Preparing the manuscript

- Guidelines for authors
- The IMRAD format

2.3 Title, Byline, Abstract and Summary, Keywords

2.4 Introduction:

- Defining the problem
- Literature survey
- Justification of study

2.5 Materials and Methods:

- Contents
- Sources
- Procedures
- Techniques
- Reproducibility
- Significance

2.6 Results:

- Text
- How to present data
- Tables and illustrations
- Writing captions
- Labels and legends

2.7 Discussion:

- Components and Sequence
- Analysis, Comparison and Integration of Data
- Likely Sources of Errors in Results

2.8 Conclusions and significance

Unit 3: Project **(30 L)**

Objective

- *To familiarize learner for analyzing a scientific occurrence with an investigation or to solve a problem with an invention.*

Desired Outcome

- *Research expands the current state of knowledge (at a certain cost) of the learners.*
- *Experimental findings that may yield new insights or lead to other research among the learners.*

1. **Dissertation 60 Marks**
2. **Examinations 50 Marks**

Guidelines to the Project:

1. **The Project shall include:**
   - Title of the Project
   - Aims, Objectives and Rationale
   - Materials and Methods
   - Observation and / Results
   - Interpretation of Observation / Results and Discussion
   - Conclusion and / Recommendation
   - Relevance of Work / Justification of Work with Project title
   - Relevant References

2. **The project must be type-written using computer and printed for binding.**

3. **No minimum or maximum limit of the number of pages is defined since the volume of the proposal is dependent on the scope of the selected topic.**

4. **Name of the mentor may be reflected on the first page of the project along with the student's names.**

5. **The hard copy of proposal must be retained and submitted along with the dissertation in the examination for the reference of the external examiner/s.**

6. **Student should prepare individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.**

7. **The project will be prepared individually by students.**

M. Sc. Part 2: Semester IV Practical
Practical 1: PSZOOCN4P1
Capture Fisheries

1. Identification, Classification of Marine fishes w.r.t. Fishery Aspects on the following: List of Marine fishes:
   A. Elasmobranchs:
      a) Family Carcharidae: *Carcharias sps., Zygaena malleus*
      b) Family Rhinobatidae: *Rhynchobatus djiddensis*
      c) Family Trygonidae: Himantura uarnak *(Trygon urnak)*
   B. Teleost:
      a) Family Percidae: *Lutjanus johnii, Therapon sps., Nemipterus japonicus (Synagris japonicus)*
      b) Family Squamipinnes: *Scatophagus argus*
      c) Family Polynemidae: *Eleutheronema tetradactylum (Polynemus tetradactylus),*
      d) Family Sciaenidae: *Sciaena sps.*
      e) Family Trichuridae: *Lepturacanthus savala (Trichiurus savala) (haumela)*
      f) Family Carangidae: *Caranx rottleri*
      g) Family Stromatidae: *Pampus argenteus, Pampus chinensis (Stromateus sinensis),*
      h) Family Scombridae: *Rastrelliger kanagurta, Cybium guttatum*
      i) Family Gobidae: *Boleophthalmus sps.*
      j) Family Mugillidae: *Mugil sps.*
      k) Family Pleuronectidae: *Psettodes erumei, Cynoglossus elongatus*
      l) Family Scopelidae: *Saurida tumbil, Harpodon nehereus*
      m) Family Sombresocidae: *Strongylura strongylura (Belone stongylurus), Hemiramphus sps.*
      n) Family Clupeidae: *Sardinella longiceps (Clupea longiceps)*
      o) Family Chirocentridae: *Chirocentrus dorab*
      p) Family Muraenesox: *Muraenesox sps.*

2. Plotting the frequency polygon by ova diameter measurement.

3. Biometric studies of fish / prawn
   a) Study of relationship between total length and standard length / head length / body depth length / body weight.
   b) Calculate correlation (standard length and total length, head length and total length, body depth and total length). Calculate the index values for various relationships.

4. Identification & Classification of fresh water, estuarine and marine non fish marine organisms

   a) Tilapia,
   b) Cat fishes (*Clarius magur, Wallago attau, Mystus sp.*)
   c) Fresh water prawn (*Macrobrachium rosenbergii*)
   d) Hilsa fishery, Mullet fishery
   e) Trout and Mahaseer
   f) Lobster (*Panulirus sp.)*

5. Study of crafts and gears used on the East and West coast of India.

6. Visit to fish landing centre / local fish market.

Practical 2: PSZOOCN4P2
Brackish and Marine Water Aquaculture

1. Identification *Peneaus monodon, Scylla serrata, Lates calcarifer*, Mullet, Milk fish, Pearl Oyster.

2. Identification of various farm equipment such as feeding cups, trays, paddle wheels, aerators, fountains, Sluice gate models, elbow pipe outlets.

3. Identification of Aquaculture feed:
   - Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids.
   - Culture of earthworms, bait fish and forage fish.

4. Identification of fin fish and shell fish diseases
   a) Fungal Diseases – Saprolegniasis, Branchiomycosis
   b) Bacterial Diseases – Fin and Tail rot, Ulcer diseases, Dropsy, Eye diseases, Ferunculosis, Bacterial Gill diseases, ERM, Edwardsiellosis, Vibriosis
   c) Protozoan Diseases – White spot diseases, Costiasis, Trichodinosis, Whirling disease
   d) Metazoans – Dactylogyrus, Gyrodactylus, Hirodinosis, Lernaea, Argulus
   e) Viral diseases – IPN, IHN, VHs, CCVD, EUS.

5. Aquaculture medicines and its importance in fisheries:
   Geotox, aquanone, Bio-ox, sodium chloride**,** formalin, malachite green, methylene blue, potassium permanganate, hydrogen per oxide and glutaraldehyde phostoxin, dipterex, antimicrobials, copper sulphate, sumithion, melathion

6. Visit to fish farming and submit its report.

PRACTICAL 3: PSZOOCN4P3
INDUSTRIAL FISHERY

1. Preparation of value added products:
   a) Fish/Prawn Pickle
   b) Fish Chakli and wafers
   c) Artificial products/crabs streaks
   d) Fish Kabab
   e) Fish cuttlet
   f) Fish Amoti
   g) Fish Rumani
   h) Fish fillets

2. Preparation of fish by-products:
   a) Fish Protein Concentrate
   b) Fish body oil
   c) Fish meal
   d) Chitosan
   e) Isinglass

3. Identification of packaging materials:
   a) Simple & Lacquered Cans
   b) Polyolefin Films
   c) Waxed Duplex cartons
   d) Retort Pouches
   e) Corrugated Fibre Board box

4. Fish market survey to study (any one):
   a) Fluctuations in the availability and price of fish
   b) Various preserved & processed fish / prawns
   c) The availability of various by products, value added products and its price
   d) Various packaging materials used in fish processing industries

Practical 4: PSZOOCN4P4
Instrumentation and Presentation of Scientific data

The practical of Semester 4 paper 4 comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc. They are expected to abide rules of Scientific Research and if possible derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research. Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables. Learners will gain l knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles.
Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology. In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees. The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

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University of Mumbai
M.Sc. ZOOLOGY (Oceanography and Fishery Technology)
Semester III / Semester IV EXAMINATIONS

Modality of Assessment

A. Internal Assessment 40%

Sr. No.	Evaluation type	Total Marks
1	One Assignments / Case study	25
2	Active participation in routine class instructional deliveries	05
3	Attendance – (0-25% = 0 marks, 25-50% = 1mark, 50-75% = 3 marks and 75-100%= 5 marks)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular, etc.	05

B. External Assessment 60%

a. Semester End Examination 60 Marks
   - Duration – These examinations shall be of two and half hours duration for each paper.
   - Theory Question Paper Pattern:
     - There shall be five questions each of 12 marks. On each unit there will be one question and the first one will be based on entire syllabus.
     - All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 30 marks with options.
     - Question may be subdivided into sub questions a, b, c… and the allocation of marks depend on the weightage of the topic.

b. Practicals: 50 Marks

c. Project in Semester IV: Internal Examination 40 Marks
   Dissertation: 60 Marks
   External Evaluation: 50 Marks

***Note - The practicals may be conducted by using specimens authorized 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 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 are done.

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, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

University of Mumbai
M.Sc. ZOOLOGY (Oceanography and Fishery Technology) Paper Pattern of
Semester III (Papers 1, 2, 3, 4) / IV (Papers 1, 2, 3) Examination

Maximum Marks: 60 **Duration: 2.5 Hours** **Marks Option: 90**

Question 1. Based on Unit I to IV (Mixed Questions)
Question 2. Based on Unit I
Question 3. Based on Unit II
Question 4. Based on Unit III
Question 5. Based on Unit IV

Instructions:
a. All questions are compulsory.
b. All questions carry equal marks.
c. Draw neat and labelled diagrams wherever necessary.

1. Answer any **four questions** from the following: (Based on all 4 Units) **(12)**
a)
b)
c)
d)
e)
f)

2. Answer any **two questions** from the following: (Based on Unit I) **(12)**
a)
b)
c)

3. Answer any **two questions** from the following: (Based on Unit II) **(12)**
a)
b)
c)

4. Answer any **two questions** from the following: (Based on Unit III) **(12)**
a)
b)
c)

5. Answer any **two questions** from the following: (Based on Unit IV) **(12)**
a)
b)
c)

Semester IV Examination
Paper IV: Instrumentation and Presentation of Scientific data
Internal (Theory) Paper Pattern of PSZOOCN404

Maximum Marks: 40 **Duration: 1.15 Hours** **Marks Option: 60**

Instructions:

a. All questions are compulsory.
b. Draw neat and labeled diagrams wherever necessary.

1. Fill in the blank by choosing the correct option given in the brackets (Based on both Units) Four sub-questions from each unit. **(08)**

2. Answer any **two questions** from the following: (Based on Unit I) **(16)**
   a)
   b)
   c)

3. Answer any **two questions** from the following: (Based on Unit II) **(16)**
   a)
   b)
   c)

Skeleton of Practical Examination Question Paper Practical Paper 1: PSZOOCN3P1

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1. Estimate the Salinity and Silicates of the given water sample. **14**

   OR

1. Estimate the primary productivity using light and dark bottle method of the given water sample. **14**

2. Quantitative estimation of plankton using settling method / wet weight method / weight displacement method / counting method. **08**

   OR

2. Analyze and make a report of gut contents of the fishes provided. **08**

3. Identification **18**
   a) Oceanographic instrument
   b) Oceanographic instrument
   c) Intertidal organism – Rocky shore
   d) Intertidal organism – Sandy shore
   e) Intertidal organism – Muddy shore
   f) Zooplankton

4. Viva voce based on Theory. **05**

5. Journal. **05**

Skeleton of Practical Examination Question Paper
Practical 2: PSZOOCN3P2

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1. Estimation of Turbidity and pH / Hardness and CO_2 of the given pond water sample. **10**
   OR
1. Estimation of BOD of given pond water sample. **10**

2. Submit a report on setting and maintenance of aquarium and viva voce based on it. **07**
   OR
2. Identification of characteristics of male and female *Macrobrachium rosenbergii.* **07**

3. Identify and describe. **18**
   a) Candidate species of fish / crustacean
   b) Ornamental fish
   c) Aquatic plant used in aquarium
   d) Developmental stage in fish
   e) Developmental stage in *Macrobrachium rosenbergii*
   f) Component of fish hatchery

4. Viva voce based on Theory. **05**

5. Journal and Field Report. **10**

Skeleton of Practical Examination Question Paper:
Practical 3: PSZOOCN3P3

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1.	Estimate moisture content from the given fish sample.	**12**
	OR	
1.	Sketch the layout of ice factory / cold storage / freezing industry / canning industry.	**12**
2.	Differentiate between fresh fish or prawn on the basis of organoleptic tests.	**11**
	OR	
2.	Prepare the shrimps for processing after dressing and grading.	**11**
	OR	
2.	Demonstrate fish dressing and filleting of fish.	**11**
3.	Identification (a to d) based on practical 4 and 7.	**12**
4.	Viva based on Theory.	**05**
5.	Journal and Field Report.	**10**

Skeleton of Practical Examination Question Paper
Practical 4: PSZOOCN3P4

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1. Dissect any given Teleost fish so as to expose its Digestive system / Nervous system / Aortic arches. **14**

   OR

1. Dissect any given Teleost fish so as to expose its weberian ossicles. **14**

   OR

1. Dissect Crab so as to expose its circulatory system. **14**

2. Determine ammonia from the given tank water. **05**

3. Make a temporary preparation of (stain if necessary) **12**
   a) Fins / Gills and rakers / Clasper / Walking leg
   b) Hectocotylus arm / Rostrum / Chelate leg
   c) Pleopod / Uropod / Antenna / Antennule
   d) Scales / Air bladder

4. Identify and describe. **09**
   a) Schooling /One Mollusc
   b) Shoaling /One Crab Larva
   c) One crab / One air breathing fish

5. Viva voce based on Theory. **05**

6. Journal. **05**

Skeleton of Practical Examination Question Paper
Practical 1: PSZOOCN4P1

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1. **Major:**
   A. Identify and assign the given fishes to their respective genera and species. **12**
      i. Elasmobranch
      ii. Teleost
      iii. Teleost
      iv. Teleost
   B. One Fish with Francis Day Volume. **05**

2. **Minor:**
   Measure ova diameter and plot a frequency polygon for the given fish. **09**
   OR
   From the data provided present an account of biometric parameters of the given fish.
      i) Study of relationship between total length and standard length / head length / body depth / body weight. **05**
      ii) Calculate its correlation. **04**

3. Identify and comment on Inland fisheries, Estuarine and marine Shell fish resource organisms. **09**
      a) Specimen
      b) Craft
      c) Gear

4. Viva–voce based on Theory. **05**

5. Report based on Visit to fish Landing Centre / Local fish market and Journal. **10**

Skeleton of Practical Examination Question Paper:
Practical 2: PSZOOCN4P2

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1. Identify and describe their importance in fisheries **12**
   (Any four photographs of Aquaculture medicines)

2. Identify and describe. **10**
   (Any four photographs of equipment of fish farming)

3. Identify and describe their treatment. **09**
   (Any three Fin fish and Shell diseases)

4. Identify and describe. **04**
   Any two from *Peneaus monodon, Scylla serrata, Lates calcarifer,* Mullet, Milk fish, Pearl Oyster

5. Vive voce based on theory. **05**

6. Journal. **05**

Skeleton of Practical Examination Question Paper:
Practical 3: PSZOOCN4P3

Time: 10:00 am to 3:00 pm **Total Marks: 50**

1. Preparation of any one value added product / by-product: **20**
   Fish / Prawn Pickle / Fish Kabab / Fish cutlet / Fish Protein Concentrate / Fish body oil / Fish meal

2. Identify and describe packaging material (three spots). **15**

3. Viva voce based on theory. **05**

4. Journal and fish marketing survey report. **10**

Skeleton of Practical Examination
Question Paper: Practical 4 PSZOOCN4P4

Evaluation of Project of Paper IV Project: 60 Marks

1.	Title of the Project	**01**
2.	Aim, Objectives and Rationale	**04**
3.	Materials and Methods	**05**
4.	Observations and / Results	**10**
5.	Interpretation of Observations / Results and Discussion	**10**
6.	Conclusion and / Recommendation	**10**
7.	Relevant work / Justification of work with Project title	**10**
8.	Relevant References	**05**
9.	Certified Dissertation	**05**

External Evaluation: 50 Marks

1.	Content of Presentation	**10**
2.	Quality of Presentation	**10**
3.	Presentation Skill	**10**
4.	Quality of Work	**10**
5.	Viva based on Proposal / Question Answer Session	**10**

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