# THE MAHATMA GANDHI UNIVERSITY

# UNDER GRADUATE PROGRAMMES

# (HONOURS) SYLLABUS

# MGU-UGP (Honours)

## (2024 Admission Onwards)

# Faculty:Science

# BoS: Aquaculture

# Subject: Aquaculture

**Mahatma Gandhi University**
**Priyadarshini Hills**
**Kottayam – 686560, Kerala, India**

# MGU-UGP (HONOURS)

# Syllabus

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# PREFACE

The Kerala Higher Education Reforms Commission has recommended a comprehensive reform in the undergraduate curriculum , adopting 4 year undergraduate programs to bring Kerala's undergraduate education at par with well acclaimed universities across the globe. The curriculum provides a flexible choice based credit system, multidisciplinary approach, multiple entry and exit options and establish three broad pathways. (a) 3-year UG Degree (b). 4-year UG Degree (Honours) and (c). 4-year UG Degree (Honours with Research).

The curriculum developed is part of a continuing process and effort for the dynamic improvement of the existing curriculum and education system. The fourty nine courses included in the syllabus, under various categories like Discipline Specific Courses, Multidisciplinary Courses, Value enhancement courses and Skill Enhancement courses have been designed to improve the existing syllabus and to make it more contextual and pertinent to cater to the needs of students in terms of global competetiveness and employability.

Aquaculture has long been looked upon as a practical science with the potential to ensure food security and eliminate hunger. A revolution in aquaculture aptly named 'Blue Transformation' by the Food and Agricultural organization , outlines a vision to expand aquatic food systems and increase their contribution to nutritious and affordable healthy diets, ensuring environmental stewardship and inclusive growth, especially for those communities that depend on Fisheries and Aquaculture.

Aquatic food are increasingly recognized for their key role in food security and Nutrition, not just as a source of protein, but also as a unique and extremely diverse provider of essential omega 3 fatty acids and bioavailable micronutrients.

The contribution of Aquaculture to the global production of aquatic animals reached a record 49.2 percent in 2020, in which year the global capture fisheries production was 90.3 million tonnes, with an estimated value of USD 141 billion.

As a science aquaculture has evolved into a multidisciplinary subject, with contributions from all other branches of knowledge.

The present syllabus has been prepared, incorporating the changing landscape of the educational system and in tune with the aspirations and futuristic views of the student community.

As mentioned earlier, syllabi for different types of courses has been prepared. Discipline Specific Courses are for the students specializing in aquaculture and covers a range of basic and advanced topics in the subject. Some of the courses include Aquaculture Tourism, where the scope of Aquaculture is explored and widened to include the ever burgeoning tourism industry, which fetches both employment opportunities and income. Artificial intelligence, which provides cutting edge

technology has been included as a course 'Artificial Intelligence in Aquaculture', which explores the realms of possibilities in automating aquaculture and decision making. The multidisciplinary courses, meant for students pursuing other fields of knowledge, include basic courses in aquaculture as well as ornamental fish culture and fishery byproducts. The Skill enhancement courses include Aquafarm Management, Aquarium Fabrication and Fish feed Technology, all areas in which practical skill is needed. The value added courses include Management of aquatic pollution, Sustainable Aquaculture and Socioeconomic upliftment through Fisheries. The mandatory internship is aimed at providing hands on skill in practical areas like fish processing technology and farm management.

The advice and assistance provided by the expert committee, participants in the FYUGP workshop and all others associated with the preparation of the FYUGP syllabus in B.Sc. Aquaculture (Honours) is gratefully acknowledged.

**Dr.K.J.Abraham**
**Chairperson (Board of Studies in Aquaculture UG and PG Combined)**
**Mahatma Gandhi University, Kottayam.**

# BOARD OF STUDIES & EXTERNAL EXPERTS

**Board of Studies in Aquaculture (2021-2024),**

**Mahatma Gandhi University, Kottayam**

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| 11 | Dr.Rekha Parthasarathy<br>Assistant Professor and Research Guide,<br>Dept. of Zoology<br>SNM College, Maliankara. | Member | 9495264994<br><br>8921374764 | rekha.parthasarathy@yahoo.com<br><br>rekhasnmc@gmail.com |

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| Dr. Prajith, K.K. | Senior Scientist, Fishing Technology Division, CIFT | 9447726227 |
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| Prof. Dr. Mohamed Hatha | Director, School of Marine Sciences, CUSAT, Kochi 682016 | 8882197762 |
| Dr.T.V. Anna Mercy | Retd Professor (KUFOS) and Head of Dept. of. Aquaculture; SH College, Thevara | 9447667069 |
| Prof. Dr. M. Harikrishnan | Professor,<br>School of Industrial Fisheries<br>Cochin University of Science and Technology<br>Ernakulam- 682022 | 9746604222 |

## Syllabus Index

**Name of the Major: Aquaculture**

### Semester: 1

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours / week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG1DSCAQC100 | Introduction to Aquaculture Systems and Resources | DSC A | 4 | 5 | 3 | - | 2 | |
| MG1MDCAQC100 | General Perspectives in Aquaculture | MDC | 3 | 4 | 2 | - | 2 | - |

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

### Semester: 2

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours / week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG2DSCAQC100 | Ornamental Fish Culture and Breeding | DSC A | 4 | 5 | 3 | | 2 | |
| MG2MDCAQC100 | Introduction to Aquarium and Ornamental Fishes. | MDC | 3 | 4 | 2 | - | 2 | - |

## Semester: 3

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours / week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG3DSCAQC200 | Culture of Fish Food Organisms | DSC A | 4 | 4 | 4 | - | - | - |
| MG3DSCAQC201 | Taxonomy and Morphology of Finfishes. | DSC A | 4 | 5 | 3 | - | 2 | - |
| MG3DSCAQC202 | Anatomy and Physiology of Finfishes and Shellfishes . | DSC B | 4 | 5 | 3 | - | 2 | |
| MG3DSEAQC200 | Seaweed Culture and Utilisation | DSE* | 4 | 5 | 3 | - | 2 | - |
| MG3DSEAQC201 | Aquatic Ecology, Water and Soil Quality Parameters. | DSE* | 4 | 5 | 3 | - | 2 | - |
| MG3DSEAQC202 | Reproductive Biology and Endocrinology | DSE* | 4 | 5 | 3 | - | 2 | |
| MG3MDCAQC200 | Fishery Byproducts and Value Addition. | MDC | 3 | 3 | 3 | - | 0 | - |
| MG3VACAQC200 | Aquatic Pollution and Management. | VAC | 3 | 3 | 3 | - | 0 | - |

*** DSE Select any 1**

## Semester: 4

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours/ week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG4DSCAQC200 | Nutrition and feeding of Fishes | DSC A | 4 | 5 | 3 | - | 2 | |
| MG4DSCAQC201 | Taxonomy and Morphology of Shellfishes. | DSC A | 4 | 4 | 4 | - | - | - |
| MG4DSCAQC202 | Reproductive Physiology, Endocrinology and Induced Breeding Techniques . | DSC C | 4 | 5 | 3 | - | 2 | |
| MG4DSEAQC200 | Advanced Aquaculture Production Systems | DSE* | 4 | 5 | 3 | - | 2 | |
| MG4DSEAQC201 | Fishing Craft and Gear Technology | DSE* | 4 | 5 | 3 | - | 2 | |
| MG4DSEAQC202 | Physiology and Internal organisation of Finfishes and Shellfishes | DSE* | 4 | 5 | 3 | - | 2 | |
| MG4DSEAQC203 | Seed Production and Hatchery Management of Shellfishes | DSE* | 4 | 5 | 3 | - | 2 | |
| MG4SECAQC200 | Aquafarm Management | SEC | 3 | 3 | 3 | - | - | |
| MG4VACAQC200 | Sustainable Aquaculture Practices | VAC | 3 | 3 | 3 | - | - | |
| MG4INTAQC200 | Internship | | 2 | | | | | |

*** DSE- Select Any one**

**Semester: 5**

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours / week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG5DSCAQC300 | Seed Production and Hatchery Management of Finfishes | DSC A | 4 | 5 | 3 | - | 2 | |
| MG5DSCAQC301 | Post Harvest Technology and Quality Control | DSC A | 4 | 5 | 3 | - | 2 | |
| MG5DSEAQC300 | Inland and Marine Capture Fisheries | DSE* | 4 | 4 | 4 | - | - | |
| MG5DSEAQC301 | Fish Genetics and Biotechnology | DSE* | 4 | 4 | 4 | - | - | |
| MG5DSEAQC302 | Value Added Fishery Products and Byproducts | DSE* | 4 | 4 | 4 | | | |
| MG5DSEAQC303 | Aquaculture Ecosystem Management and Climate Change | DSE* | 4 | 4 | 4 | | - | |
| MG5DSEAQC304 | Coldwater Aquaculture, Recreational Fisheries and Integrated Multitrophic Aquaculture | DSE* | 4 | 4 | 4 | - | - | |
| MG5SECAQC300 | Fabrication and Setting of Marine and Freshwater Aquarium | SEC | 3 | 3 | 3 | - | - | |

***DSE- Select Any 3**

## Semester: 6

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours/ week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG6DSCAQC300 | Coastal Aquaculture and Mariculture | DSC A | 4 | 5 | 3 | - | 2 | |
| MG6DSCAQC301 | Fish Microbiology and Quality Assurance of Seafood | DSC A | 4 | 5 | 3 | - | 2 | |
| MG6DSEAQC300 | Fish Pathology, Immunology and Health Management | DSE* (Bunch 1) | 4 | 5 | 3 | - | 2 | |
| MG6DSEAQC301 | Management of Ornamental Fish Culture | DSE* (Bunch 1) | 4 | 5 | 3 | | 2 | |
| MG6DSEAQC302 | Fisheries Economics and Extension | DSE* (Bunch 2) | 4 | 4 | 4 | - | - | |
| MG6DSEAQC303 | Fish Biochemistry | DSE* (Bunch 2) | 4 | 4 | 4 | | - | |
| MG6SECAQC300 | Preparation of Artificial Fish Feed in Aquaculture | SEC** | 3 | 3 | 3 | - | - | |
| MG6SECAQC301 | Preservation Techniques for Aquatic Specimens and Museum Collections | SEC** | 3 | 3 | 3 | | | |
| MG6VACAQC300 | Socioeconomic Upliftment through Fisheries | VAC | 3 | 3 | 3 | - | - | |

* DSE Select Any one from Bunch 1

* DSE Select Any one from Bunch 2

** SEC Select any one from SEC

## Semester: 7

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours/ week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG7DCCAQC400 | Biophysics, Instrumentation and Microtechniques | DCC | 4 | 5 | 3 | - | 2 | |
| MG7DCCAQC401 | Fish Population Dynamics | DCC | 4 | 4 | 4 | - | - | |
| MG7DCCAQC402 | Aquatic Toxicology | DCC | 4 | 4 | 4 | - | - | |
| MG7DCEAQC400 | Fisheries Oceanography | DCE | 4 | 4 | 4 | - | - | |
| MG7DCEAQC401 | Aquaculture Engineering | DCE | 4 | 4 | 4 | | | |
| MG7DCEAQC402 | Deep Sea Fisheries, GIS and Remote Sensing | DCE | 4 | 4 | 4 | - | - | |

**DCC Discipline Specific Capstone Component**

**DCE Discipline Specific Capstone Elective**

## Semester: 8

| Course Code | Title of the Course | Type of the Course DSC, MDC, SEC etc. | Credit | Hours/ week | Hour Distribution /week | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | O |
| MG8DCCAQC400 | Research Methodology and Biostatistics | DCC | 4 | 5 | 3 | - | 2 | |
| MG8DCCAQC401 | Fisheries Marketing and Trade . | DCC | 4 | 5 | 3 | - | 2 | |
| MG8DCEAQC400 | Sustainable Aquaculture Policy and Planning | DCE | 4 | 5 | 3 | - | 2 | |
| MG8DCEAQC401 | Aquaculture Tourism | DCE | 4 | 5 | 3 | | 2 | |
| MG8DCEAQC402 | Artificial Intelligence in Aquaculture | DCE | 4 | 5 | 3 | - | 2 | |
| MG8PRJAQC400 | Project | PRJ | 12 | | - | - | - | |

**DCC Discipline Specific Capstone Component**

**DCE Discipline Specific Capstone Elective**

# SEMESTER 1

# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **INTRODUCTION TO AQUACULTURE SYSTEMS AND RESOURCES** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG1DSCAQC100** | | | | | |
| **Course Level** | **100** | | | | | |
| **Course Summary** | Aquaculture is the breeding, raising, and harvesting fish, shellfish, and aquatic plants. It 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.Through aquaculture, our oceans, seas, and inland freshwaters hold huge potential to provide us with increased amounts of healthy and Nutritious Food.. This is needed to feed an ever growing human population so aquaculture helps us with our 'food security'. This paper introduces the basics of Aquaculture. | | | | | |
| **Semester** | **1** | Credits | | | **4** | |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | Total Hours |
| | | 3 | | 1 | | 75 |
| **Pre- requisites, if any** | Basic knowledge regarding classification of animal kingdom and Ecology is desirable | | | | | |



**COURSE OUTCOMES (CO)**

| CO.No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Differentiate different types of Aquaculture systems | R | 4,10 |
| 2 | Understand Pond Structure and Construction | U | 1 |
| 3 | Analyse different agri and livestock based system | An | 2 |
| 4 | Outline the economic benefits of integrated farming techniques | A | 1 |

| | | | |
|---|---|---|---|
| 5 | Categories of different cultivable organisms based on their external characteristics | U | 3 |
| 6. | Evaluates new strategies in aquaculture development | E | 3 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to AI in Aquaculture and Fisheries Management** | | **10 Hours** | |
| | 1.1 | Introduction to Aquaculture- Scope and Potential of Aquaculture in Indian scenario and the world | 3 | 1 |
| | 1.2 | Importance of Aquaculture as compared to Agriculture and Capture Fisheries.<br>Qualities of Candidate species for Aquaculture | 3 | 1 |
| | 1.3 | Types of Aquaculture - fresh water, brackish water, Mariculture and Metahaline culture.<br>Classification based on structure -Pond culture, raceway culture, Tank culture, floating cages, Pen culture, Rack, raft culture, long line culture, On Bottom Culture.<br>Classification based on type – Monoculture, Monosex culture , Polyculture | 5 | 1 |
| | 1.4 | Extensive, semi -intensive and Intensive methods of Aquaculture. | 2 | 1 |
| | 1.5 | Static and Open systems of Aquaculture, based on water exchange. | 2 | 1 |
| **2** | **Pond Culture and Integrated Farming** | | **15 Hours** | |
| | **2.1** | Type of fish ponds,Structure, Design and Construction of Fish Ponds.<br>Water Controlling structures in Fish Ponds – Sluice gates | 3 | 2 |
| | **2.2** | Water and Soil Quality parameters in Pond Fish Culture.<br>Pre-stocking and Post Stocking Management of Ponds | 3 | 2 |
| | **2.3** | **Integrated Farming-** Introduction, Scope and Salient Features<br>Sewage Fed Fish Culture | 3 | 3 |
| | **2.4** | Agri based Farming- Paddy-cum-fish culture, Banana-cum- fish culture. Mulberry cum fish culture | **3** | 3 |

| | | | | |
|---|---|---|---|---|
| | **2.5** | Live stock based Farming- Pig-cum-fish culture, Poultry-cum-fish culture, Cattle-cum-fish culture, Duck-cum-fish culture.<br>Economics of Integrated Farming | **3** | 3 |
| **3** | **Cultivable Aquaculture resources and Recent Trends in Aquaculture Practices** | | **15 Hrs** | |
| | **3.1** | Cultivable fin fishes- carps-indigenous and exotic species- Air breathing fishes, Cold water fishes, Sport fishes, Tilapia, Etroplus- Morphological features and Classification | **3** | 4 |
| | **3.2** | Cultivable Shellfishes – Morphological features and classification.<br>Crustaceans- Fresh water prawn, Shrimps, Crab<br>Molluscs- Mussels, Pearl oyster, Edible oyster, clams | 3 | 4 |
| | **3.3** | Cultivable Echinoderms - Sea urchin, Sea cucumber<br>Cultivable Sea weeds | 3 | 4 |
| | **3.4** | **Recent Trends in Aquaculture Practices:**<br>Recirculating Aquaculture systems<br>Biofloc technology | 3 | 5 |
| | **3.5** | IMTA(Integrated multitrophic Aquaculture<br>Aquaponics/Hydroponics | 3 | 5 |
| **4** | **PRACTICALS** | | **30 Hours** | |
| | **4.1** | Identification of Cultivable Finfishes | 5 | 4 |
| | **4.2** | Identification of Cultivable Crustaceans | 5 | 4 |
| | **4.3** | Identification of cultivable bivalves<br>Identification of Sea urchins, Sea Cucumbers and Sea Weeds. | 5 | 4 |
| | **4.4** | Identification of different culture systems | 5 | 1 |
| | **4.5** | Setting up of an Aquaponics system or recirculating water system. | 5 | 5 |
| **5** | **Teacher Specific content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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23. Wheaton, F. W. (1993). *Aquacultural engineering*. Krieger Publishing Co.

**SUGGESTED READINGS**

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2. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and practices* (2nd ed.). Wiley-Blackwell.

3. Rath, R. K. (1993). *Freshwater aquaculture*. Scientific Publishers.

# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | | | | | | |
| **Course Name** | **GENERAL PERSPECTIVES IN AQUACULTURE** | | | | | |
| **Type ofCourse** | **MDC** | | | | | |
| **Course Code** | **MG1MDCAQC100** | | | | | |
| **Course Level** | **100** | | | | | |
| **Course Summary** | Aquaculture, the cultivation of aquatic organisms, has emerged as a vital component of global food production and economic development. This course provides a comprehensive prelude to introduction to aquaculture, branches of aquaculture, aquaculture environment, and scope of aquaculture . Designed for individuals with diverse backgrounds, this course offers a solid foundation for understanding the multifaceted world of aquaculture. | | | | | |
| **Semester** | **1** | Credits | | | **3** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 2 | | 1 | | 60 |
| **Pre- requisites, if any** | Students should possess knowledge regarding general characters of animal kingdom. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Identifies different types and systems of aquaculture | U | 1,2 |
| 2 | Analyze the different parameters which determines the quality of water essential for good aquatic life . | A | 1,2 |
| 3 | Comprehend marketing strategies in aquaculture | An | 1,2 |
| 4 | Investigate the role of various water pollutants | C | 1,2 |
| 5 | Manifest skill in checking the water quality of nearby water bodies. | E | 1,2 |
| 6 | Develop fundamental skills in fabricating and setting up of an aquarium | A, S | 2,10 |

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | **Introduction To Aquaculture, Culture Systems, Aquaculture and the Environment** | **15 Hours** | | |
| 1 | 1.1 | Definition of aquaculture, brief history and development of aquaculture .<br>Advantages of Aquaculture over Capture Fishery and Agriculture | 1 | 1 |
| | 1.2 | Candidate Species in Aquaculture- Requirements of Candidate Species<br>Candidate Species of Fishes , Crustaceans, Bivalves, Abalones, Seaweeds. | 3 | 1 |
| | 1.3 | Types of aquaculture – fresh water aquaculture , brackish water aquaculture, mariculture and metahaline aquaculture , Areas available for Aquaculture | 2 | 1 |
| | 1.4 | Scope of aquaculture, Aquacultural education, research on aquaculture and hazards for aquaculture | 2 | 1 |
| | 1.5 | Extensive culture , intensive culture, semi – intensive culture, Monoculture , polyculture, mono sex culture ,Cage culture , pen culture, Raceway culture, Raft culture , Longline culture, Rack Culture. | 2 | 2 |
| | 1.6 | Water quality parameters – Physical – temperature , turbidity, conductivity , hardness . Chemical – Salinity , $P^H$ , Dissolved oxygen , BOD, COD , ORP , TDS . Ammonia, Nitrite , Phosphate<br>**Activity** – checking the water quality of nearby water bodies | 3 | 3 |
| 1 | 1.7 | Water quality management , waste management , habitat conservation and restoration<br>Water pollution and its effects on aquatic life | 2 | 3 |
| 2 | **Ornamental Fishes, Aquarium Setting, Aquaculture Economics, marketing and Aquapreneurship** | **15 Hours** | | |
| 2 | 2.1 | Common aquarium fishes – Gold fish , tiger barb , Sword tail , platy , guppy , fighter | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| | 2.2 | Requirements for an aquarium , aquarium fabrication and setting, Aquarium plants, Aquarium Accessories , Ornamental fish trading<br>**Activity** – Construct an aquarium using glass or Visit a near by aquarium and prepare a report. | 4 | 4 |
| | 2.3 | Introduction to aquaculture economics. definition and scope of aquaculture economics | 3 | 5 |
| | 2.4 | Cost and earnings of aquaculture, aquapreneurship – definition and areas | 2 | 5 |
| | 2.5 | Introduction to aquaculture marketing. Marketing principles in aquaculture .Marketing strategies in aquaculture | 2 | 5 |
| **PRACTICAL** **30 Hours** | | | | |
| 3 | 1 | Estimation of $p^H$ water samples | 4 | 4 |
| | 2 | Estimation of turbidity of water samples | 4 | 4 |
| | 3 | Estimation of hardness of water samples | 4 | 4 |
| | 4 | Estimation of salinity, alkalinity | 4 | 4 |
| | 5 | Estimation of Nitrite, Phosphate, Ammonia | 4 | 4 |
| | 6 | Estimation of dissolved oxygen and BOD of water samples | 4 | 4 |
| | 7 | Estimation of $CO_2$ | 2 | 2 |
| | 8 | Aquarium making , Aquarium Accessories | 4 | 4 |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 15 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (5 out of 9) 5 X 3 = 15 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total= 35 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks |

| | |
|---|---|
| | • Viva = 3 Marks<br>• Total = 35 Marks |

**REFERENCES**


1. Aravind Kumar. (2004). *Fishery management*. APH Publishing Corporation.
2. Badapanda, K. C. (2012). *Aquaculture* (Vol. 1). Narendra Publishing House.
3. Balakrishnan Nair, N., & Thampi, D. M. (1980). *A textbook of marine ecology*. Macmillan.
4. Carter, R. W. G. (1998). *Coastal environments: An introduction to the physical, ecological and cultural systems of coastlines*. Academic Press.
5. De Silva, S. S., & Anderson, T. A. (1995). *Fish nutrition in aquaculture*. Chapman & Hall.
6. Dholakia, A. D. (2001). *Fisheries and aquatic resources of India*. Daya Publishing House.
7. Jhingran, V. G. (1991). *Fish and fisheries of India*. Hindustan Publishing Corporation.
8. Laevastu, T., & Hayes, M. L. (1981). *Fisheries oceanography and ecology*. Fishing News Books.
9. Lalli, C. M., & Parsons, T. R. (1993). *Biological oceanography: An introduction*. Elsevier.
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12. Pandey, N., & Davendra, S. M. (2008). *Integrated fish farming*. Daya Publishing House.
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15. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and practices* (2nd ed.). Blackwell.
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17. Sakhare, V. B. (2012). *Inland fisheries*. Daya Publishing House.
18. Vijayakumaran, & Manju. (2013). *Ornamental fish keeping*. Academica Publications.

**SUGGESTED READINGS**


1. Proceedings of the National Seminar on Riverine and Reservoir Fisheries – Challenges and Strategies. (2001). Cochin.

2. Sharma, A. P. (2012). *Management issues in inland fisheries and aquaculture*. Narendra Publishing House.

3. Society of Fisheries Technology (India). (2000). *Riverine and reservoir fisheries of India*.

4. Sugunan, V. V. (1995). *Riverine fisheries of India*. FAO Publication.

5. Sugunan, V. V. (1997). *Reservoir fisheries of India*. Daya Publishing House.

6. Welcomme, R. L. (2001). *Inland fisheries: Ecology and management*. Fishing News Books.

# SEMESTER 2

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Ornamental Fish Culture and Breeding** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG2DSCAQC100** | | | | | |
| **Course Level** | **100** | | | | | |
| **Course Summary** | India has the potential to earn about $5 billion as foreign exchange by the way of exports of ornamental fishes. India's domestic trade in this area is growing at the rate of 20% annually and demand at the domestic market is higher than the supply. This is identified as a potential area for development. This paper provides an overview of the ornamental fish resources and setting and maintenance of aquarium. The commerce and trade of ornamental fishes is also dealt with in this course. | | | | | |
| **Semester** | **2** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Basic information regarding Taxonomy of the animal kingdom is desirable. | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Students should be able to construct and maintain Home Aquarium | A | 4,10 |
| 2 | Ability to manage home as well as commercial aquarium | A | 1 |
| 3 | Prepare formulated supplementary feed for fish with locally available feed ingredients | A | 2 |

| | | | |
|---|---|---|---|
| 4 | Develop skill in breeding different aquariums fishes | An | 3 |
| 5 | Construct aquarium and take this as a self employment opportunity | A | 3 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to Aquarium and Ornamental Fishes** | | **15 Hours** | |
| | 1.1 | Definition, History, Scope and importance, | 2 | 1,2 |
| | 1.2 | Diversification in ornamental fish keeping-Aquarium keeping-as a hobby,<br>Breeding, rearing and trading of ornamental fishes | 4 | 1 |
| | 1.3 | Aquarium, Design , Aquarium accessories-, Aerators, Aquarium heaters, Thermometer, Air pump, Nets, Lighting etc<br>Filtration of Aquarium water; Types of Filters- Mechanical, Biological and Chemical Filtration. | 5 | 1 |
| | 1.4 | Aquarium plants- classification , propagation methods | **4** | 1 |
| **2** | **Common ornamental fishes and Aquarium Management** | | **15 Hours** | |
| | 2.1 | Indigenous freshwater fishes, Exotic Ornamental Fishes, Marine Ornamental Fishes, Aquarium shrimps and other Aquatic ornamental animals. | 3 | 2 |
| | 2.2 | Water quality management- source, types, water quality parameters | 3 | 2 |
| | 2.3 | Setting up and maintenance of freshwater and Marine Aquariums, Aquascaping | 3 | 2 |
| | 2.4 | Feed for ornamental fishes- live and formulated feed | 3 | 2 |
| | 2.5 | Common diseases of aquarium fishes and their control measures | 3 | 2 |
| **3** | **Commercial Production of Ornamental fishes and Ornamental Fish Trade** | | **15 hours** | |
| | 3.1 | Introduction, brood-stock management, feeding | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| | 3.2 | Breeding of Livebearers ( Guppy), Egg layers (Goldfish) and Nest Builders (Pearl Gourami)<br>Larval care and Feeding. | 3 | 4 |
| | 3.3 | **Ornamental Fish Trade-** Introduction, Procedures for Export of Ornamental Fishes, Packing. | 3 | 4 |
| | 3.4 | Funding agencies and schemes for ornamental fish culture marketing and trade | 3 | 5 |
| | 3.5 | Economics of ornamental fish culture | 3 | 5 |
| **4** | **PRACTICALS** | | **30 Hours** | |
| | 4.1 | Construction, Setting up and Maintenance of a Freshwater Aquarium | **10** | **1** |
| | 4.2 | Study of Aquarium Accessories | **4** | **1** |
| | 4.3 | Study and Setting up of Aquarium Filters | **4** | **2** |
| | 4.4 | Identification of common Indigenous and Exotic Ornamental Fishes | **4** | **2** |
| | 4.5 | Preparation of Aquarium Feed | **4** | **2** |
| | 4.6 | Hatching of Artemia cysts | **4** | **3** |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br><br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks |

| | |
|---|---|
| | • Viva = 3 Marks<br>• Total – 35 Marks |

**REFERENCES**


1. Adey, W. H., & Loveland, K. (1998). *Dynamic aquaria: Building living ecosystems*. Academic Press.
2. Dawes, J. (1995). *Live bearing fishes: A guide to their aquarium care, biology, and classification*. Cassell Pvt.
3. Dakin, N. (1996). *The Interpet questions & answers manual of the marine aquarium*. Interpet Publishing.
4. Hargreaves, V. (2007). *Complete book of the freshwater aquarium: A comprehensive reference guide to more than 600 freshwater fish and plants, plus how to set up and maintain an aquarium*. Thunder Bay Press.
5. Jennings, G. (2006). *500 freshwater aquarium fish: A visual reference to the most popular species*. Firefly Books Limited.
6. Kuravamveli, S. J. (2002). *The aquarium handbook*. Amity Aquatech Pvt. Ltd.
7. Lieske, E., & Myers, R. (1996). *Coral reef fishes*. Princeton University Press.
8. Sprung, J., et al. (2009). *Marine aquarium handbook: Beginner to breeder* (3rd ed.). Microcosm.
9. Sundararaj, V., & Sathish, J. M. (2005). *Tropical marine aquarium*. Yegam Publications.
10. Wittenrich, M. L. (2007). *The complete illustrated breeder's guide to marine aquarium fishes*. Microcosm/TFH.




**SUGGESTED READINGS**


1. Oruchowitz, D. E. (n.d.). *The simple guide to freshwater aquariums*.
2. Haridas, H., et al. (2019). *Training manual on freshwater ornamental fish breeding and aquascaping techniques*. ICAR-Central Island Agricultural Research Institute.
3. Jayashree, K. V., Tharadevi, C. S., & Arumugam, N. (2015). *Home aquarium and ornamental fish culture*. Saras Publication.

# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | | | | | | |
| **Course Name** | **Introduction to Aquarium and Ornamental Fishes** | | | | | |
| **Type of Course** | **MDC** | | | | | |
| **Course Code** | **MG2MDCAQC100** | | | | | |
| **Course Level** | **100** | | | | | |
| **Course Summary** | This course provides an overview of the aquarium hobby, focusing on the principles of setting up and maintaining aquariums, selecting and caring for ornamental fishes, and promoting responsible aquarium keeping. This course, gives emphasis on development of entrepreneurial potential and skills amongst the students. | | | | | |
| **Semester** | **2** | Credits | | | **3** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 2 | | 1 | | 60 |
| **Pre-requisites, if any** | Students should possess knowledge regarding general characters of animal kingdom. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Illustrate the design and construction of home and public aquaria | U | 1 |
| 2 | Understand the setting and maintaining of aquariums in addition to water quality management.<br>Understand the varieties of Freshwater and Marine Ornamental Fishes for culture and their habits. | U | 2 |
| 3 | Understand the handling and transport of aquarium fishes for trade and research purposes. | U | 1 |
| 4 | Develop technical know-how for ornamental fish nutrition and disease management. | AP | 1 |

| | | | |
|---|---|---|---|
| 5 | Illustrate the importance of ornamental fish culturing in relation with entrepreneurship development | U | 1 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to Aquarium Hobby** | | **10 Hrs** | |
| | 1.1 | History of Aquariums<br>Overview of the aquarium hobby<br>Benefits of an Aquarium<br>The potential scope of aquarium fish industry as a Cottage Industry<br>Importance of responsible aquarium keeping | **3** | **1** |
| | 1.2 | Types of Aquariums and their significance<br>Aquarium Accessories<br>Filtration systems | **3** | **1** |
| | 1.3 | Design and construction of public , fresh water and marine aquaria<br>Design and construction of Oceanarium<br>Activity – Construction of an aquarium | **4** | **1** |
| **2** | **Aquarium management. Nutrition and Diseases of Aquarium Fishes, Diversity of Freshwater and Marine Ornamental Fishes** | | **20 Hrs** | |
| | 2.1 | Setting up of fresh water and Marine Aquaria<br>Aquarium maintenance and water quality,<br>Quarantine Measures.<br>Control of snails and algal growth | **3** | **2** |
| | 2.2 | Types of Fish Feeds- Live, Natural and Artificial Feeds<br>Common Diseases of Aquarium Fishes- Symptoms, Prophylaxis and Treatment | **3** | **4** |
| | 2.3 | Common Species of indigenous and exotic , Live bearing and Egg Laying Freshwater Ornamental Fishes, their taxonomy and biology.<br>Breeding of Goldfish(Egg layer), Guppy (Live bearer) and *Betta* (Nest builder) | **3** | **5** |
| | 2.4 | Diversity of Freshwater aquarium plants and their classification | **3** | **5** |
| | 2.5 | Marine ornamental fishes – varieties and their habitat, | **3** | **5** |

| | | | | |
|---|---|---|---|---|
| | | Major Marine Ornamental Fish Resources of India, collection methods of Marine Ornamental Fishes. | | |
| | 2.6 | Packing and Transportation of Ornamental Fishes and use of Anaesthetics in Ornamental Fish Transportation | **3** | **5** |
| | 2.7 | Other ornamental organisms – anemones, shrimps, lobsters, star fishes | **2** | **5** |
| **3** | **PRACTICALS** | | **30 Hrs** | |
| | 3.1 | Fabrication of all-glass aquarium demonstration | 6 | 1 |
| | 3.2 | Setting-up and maintenance of aquarium | 6 | 2 |
| | 3.3 | Introduction to Aquarium accessories and equipments. | 6 | 2 |
| | 3.4 | Identification of common Marine, Live bearing and Egg Laying ornamental fishes. | 6 | 2 |
| | 3.5 | Conditioning and packing of ornamental fishes | 6 | 3 |
| **4** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 15 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (5 out of 9) 5 X 3 = 15 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total= 35 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total = 35 Marks |

## REFERENCES


1. Adey, W. H., & Loveland, K. (1998). *Dynamic aquaria: Building living ecosystems*. Academic Press.

2. Boruchowitz, D. E. (n.d.). *The simple guide to freshwater aquariums*.

3. Dawes, J. (1995). *Live bearing fishes: A guide to their aquarium care, biology, and classification*. Cassell Pvt.

4. Dakin, N. (1996). *The Interpet questions & answers manual of the marine aquarium*. Interpet Publishing.

5. Haridas, H., et al. (2019). *Training manual on freshwater ornamental fish breeding and aquascaping techniques*. ICAR-Central Island Agricultural Research Institute.

6. Hargreaves, V. (2007). *Complete book of the freshwater aquarium: A comprehensive reference guide to more than 600 freshwater fish and plants, plus how to set up and maintain an aquarium*. Thunder Bay Press.

7. Jennings, G. (2006). *500 freshwater aquarium fish: A visual reference to the most popular species*. Firefly Books Limited.

8. Jayashree, K. V., Tharadevi, C. S., & Arumugam, N. (2015). *Home aquarium and ornamental fish culture*. Saras Publication.

9. Kuravamveli, S. J. (2002). *The aquarium handbook*. Amity Aquatech Pvt. Ltd.

10. Lieske, E., & Myers, R. (1996). *Coral reef fishes*. Princeton University Press.

11. Sprung, J., et al. (2009). *Marine aquarium handbook: Beginner to breeder* (3rd ed.). Microcosm.

12. Sundararaj, V., & Sathish, J. M. (2005). *Tropical marine aquarium*. Yegam Publications.

13. Wittenrich, M. L. (2007). *The complete illustrated breeder's guide to marine aquarium fishes*. Microcosm/TFH.


## SUGGESTED READINGS


1. Jayashree, K. V., Tharadevi, C. S., & Arumugam, N. (2015). *Home aquarium and ornamental fish culture*. Saras Publication.

2. Haridas, H., et al. (2019). *Training manual on freshwater ornamental fish breeding and aquascaping techniques*. ICAR-Central Island Agricultural Research Institute.

3. Boruchowitz, D. E. (n.d.). *The simple guide to freshwater aquariums*.

# SEMESTER 3

# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Culture of fish food organisms** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG3DSCAQC200** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course equips graduate students with comprehensive knowledge and practical skills necessary for the sustainable production and effective utilization of live feeds in aquaculture. Students will gain insights into the biological, nutritional, and environmental aspects of live feed culture, preparing them to address the challenges and contribute to the advancement of aquaculture practices. | | | | | |
| **Semester** | 3 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | | | | **60** |
| **Pre-requisites, if any** | Students should possess knowledge regarding various animal groups having potential to be utilized as feed for fishes. | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains * | PO No |
|---|---|---|---|
| 1 | Demonstrate comprehensive knowledge of the principles and practices associated with the production and utilization of diverse live feeds in fish culture systems. | A,S | 1,2 |

| | | | |
|---|---|---|---|
| 2 | Evaluate the nutritional composition and biological requirements of phytoplankton and zooplankton to optimize their cultivation techniques for sustainable fish nutrition. | E | 1,2 |
| 3 | Critically assess and compare alternative live feed sources, exploring their nutritional value, cultivation methods and practical applications in varied fish culture systems. | A,E | 1,2 |
| 4 | Develops methodologies and operational techniques involved in the mass culture of Artemia, considering its significance as a crucial live feed in aquaculture | A,S | 1,2 |
| 5 | Formulates strategies for the effective incorporation of periphyton in fish culture systems, considering its ecological role, cultivation methodologies, and its potential as a supplementary or primary feed source | C,Ap | 1,2 |
| 6 | Prepares enriched live feeds with essential nutrients, including proteins, lipids (such as omega-3 fatty acids), carbohydrates, vitamins, and minerals,to improve the nutritional quality of these live feeds | A,C | 1,2 |

***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | | **Live feeds** | **15 Hours** | |
| | 1.1 | Different live feeds and their nutritional value. Manipulation of pond for natural feed production. | 4 | 1 |

| | | | | |
|---|---|---|---|---|
| | 1.2 | Candidate species of phytoplankton and zooplankton for fish and shell fish culture - diatoms, micro algae, nano plankton, artemia, copepods,cladocera and rotifers. **Activity**<br>1. Identification of fish food organisms, phytoplankton and zooplankton | 6 | 1 |
| | 1.3 | Enrichment of live feed with essential nutrients, including fatty acids, vitamins,minerals and probiotics | 5 | 1 |
| **2.** | **Culture of Phytoplankton** | | **15 hrs** | |
| 2 | 2.1 | Methods of collection, maintenance of pure culture of phytoplankton.<br>**Activity**<br>1.Collection of phytoplankton from local sources<br>2. Enumeration of Phytoplankton using Haemocytometer | 4 | 2 |
| | 2.2 | Different media used for culture. Batch culture and continuous culture and their application in hatcheries.<br>**Activity**1. Preparation of culture media | 4 | 2 |
| | 2.3 | Mass culture of important microalgae- Chaetoceros, Tetraselmis, Skeletonema, Spirulina andChlorella., Isochrysis<br>**Activity**<br>**1.**Isolation of Microalgae (Serial Dilution/Streak Plating, Micropipetting)<br>**2.** Mass Culture of Microalgae | 7 | 2 |
| | **Culture of Zooplankton and Artemia Culture** | | **15 Hours** | |

| | | | | |
|---|---|---|---|---|
| 3 | 3.1 | Methods of collection, maintenance and rearing of rotifers, cladocerans, copepods, and insect larvae.<br>**Activity**<br>Collection of zooplankton from local sources | 3 | 2 |
| | 3.2 | Mass culture of zooplankton. Harvest, storage and feeding.- Rotifers, Cladocerans, Artemia, Copepods | 5 | 2 |
| | 3.3 | Different strains of Artemia. Artemia culture. Cyst production. | 4 | 4 |
| | 3.4 | Enrichment of Artemia cyst and larvae. Decapsulation of Artemia cysts. Hatching, storage andfeeding.<br>**Activity**<br>1. Hatching of Artemia cysts and determination of Hatching rate<br>2. Decapsulation of Artemia cysts | 3 | 4 |
| | **Alternative live Feeds and periphyton culture 15 Hours** | | | |
| 4 | 4.1 | Culture methods of Infusoria, Chironomids, white worms, earthworms, mosquitolarvae, BSF larvae, tubifex worms. | 8 | 5 |
| | 4.2 | Nutritional qualities of alternative live feeds. | 2 | 5 |
| | 4.3 | .Importance of periphyton in aquaculture.Species composition and nutritionalquality. | 3 | 5 |
| | 4.4 | Methods for the development and maintenance of periphyton | 2 | 5 |

| Module 5: | Teacher Specific Module |
|---|---|

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

**REFERENCES**


1. Anderson, K., et al. (2020). Evaluation of protein sources in aquafeed formulations. *Aquaculture Nutrition*, 2020(12), 225-240.
2. Banerjee, S., & Keshavanath, P. (2017). *Aquaculture and fish nutrition*. BS Publications.
3. Bhakshi, S. (2015). *Fish nutrition and feed technology*. Daya Publishing House.
4. CMFRI, Kochi. (1981). *Manual of research methods for fish and shellfish nutrition*. CMFRI Special Publication, 8, 1-125.
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# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Taxonomy and morphology of Finfishes** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG3DSCAQC201** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course provides a comprehensive study of the morphology and taxonomy of finfish, emphasizing the structural diversity, classification, and identification of fish species. Students will gain theoretical knowledge and practical skills in fish morphology and taxonomy through lectures, laboratory work, and field experiences. | | | | | |
| **Semester** | 3 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students from diverse backgrounds, including biology, environmental science, chemistry, geology, or related disciplines, may find this course relevant to their academic interests and career goals. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understand the finfish diversity and its significance | U | 1 |
| 2 | Comprehend the sample collection methods, preservation and identification of fish | An,A | 1,2 |
| 3 | Develop skill in using dichotomous keys for the accurate identification of the fish. | C,S | 1,2 |

| | | | |
|---|---|---|---|
| 4 | Manifest skill in differentiating morphological features of fish specimens belonging to different families | E | 1,4,5 |
| 5 | Investigate molecular method for fish identification | E,S | 3 |
| 6 | Evaluate the importance of blending classical and molecular taxonomy | E,C | 1,3 |
| ***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Taxonomy and External morphology of finfish 15 Hours** | | | |
| 1 | 1.1 | Overview of finfish diversity,Importance of finfish in fisheries and ecosystems,Historical developments in fish taxonomy | 3 | 1 |
| | 1.2 | Collection, preservation,labeling and curation methods | 4 | 2,6 |
| | 1.3 | Morphological, morphometric and Meristic characters of fish | 4 | 2,6 |
| | 1.4 | Systematic position of fishes in Phylum Chordata upto orders; Use of dichotomous keys and taxonomic literature ( any family – *Eg: Elopidae,Megalopidae*) and (any genus – Eg: *Mystus* ) | 4 | 2,6 |
| | **Classification&General morphology of fin fishes 21 Hours** | | | |
| **2** | 2.1 | Classification of Super class Agnatha with examples (include systematic position and general/specific characters) | 3 | 4,6 |

| | | | | |
|---|---|---|---|---|
| | 2.2 | Classification of Super class Gnathostomata-Grade Pisces with examples(include systematic position and general/specific characters) | 3 | 4,6 |
| | 2.3 | Classification of Class Chondrichthyes (Subclass Elasmobranchii and Holocephali) with examples (include systematic position and general/specific characters) | 4 | 4,6 |
| | 2.4 | Classification of Class Osteichthyes (Subclass Dipnoi,Crossopterygii and Actinopterygii) with examples (include systematic position and general/specific characters) | 4 | 4,6 |
| | 2.5 | Classification of Actinopterygii (Infraclass Chondrostei, Holostei and Teleostei) with examples (include systematic position and general/specific characters) | 3 | 4,6 |
| | 2.6 | General characters of Orders/Families of freshwater cultivable species (Anguillidae,Cyprinidae,Siluiriformes,Anabantidae, Channidae,Salmonida,Cichlidae) and marine capture fisheries (Clupidae,Scombridae,Carangidae,Leiognathidae,Sciaenidae,Trichiuridae,Nemipteridae,Serranidae,Harpodontidae,Aridae). | 4 | 4,6 |
| **Molecular techniques in fish taxonomy 9 Hours** | | | | |
| 3 | 3.1 | DNA Barcoding techniques of fish – Procedure, DNA isolation, DNA sequencing, DNA quantification methods, Electrophoresis | 4 | 5,6 |
| | 3.2 | Karyotyping | 3 | 5,6 |
| | 3.3 | Metabarcoding | 2 | 5,6 |
| **PRACTICAL 30 Hrs** | | | | |
| 4 | 4.1 | Study of Morphology | 6 | 2 |
| | 4.2 | Dichotomous Key Identification of selected fish species | 6 | 3 |

| | | | | |
|---|---|---|---|---|
| | 4.3 | Identification of fishes up to species level | 6 | 2,3 |
| | 4.4 | Identification of scale types and fins (Cycloid, Ctenoid, Placoid) | 6 | 1,2 |
| | 4.5 | Identification of larvae of cultivable fishes (Catla, Rohu, Mrigal) | 6 | 4 |
| **5.Teacher specific Content** | | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |



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|---|---|---|---|---|---|---|
| **rogramme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Anatomy and Physiology of Finfishes and Shellfishes** | | | | | |
| **Type of Course** | **DSC B** | | | | | |
| **Course Code** | **MG3DSCAQC202** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course deals with the knowledge on how well an aquatic organism gets adapted in the aquatic ecosystem maintaining good health. Structure and functioning of different body systems such as digestive system, circulatory system, respiratory system, reproductive system and excretory system of finfishes and shell fishes are detailed. The food and feeding habits of fin fishes and shellfishesare incorporated.The study of age and growth in fish is a prerequisite to generate the infor matio on recruitment, longevity, mortality and fluctuations in fishery caused by variou s year classes, all of which can contribute towards planning for a rational exploitation of the fish stocks. The topics included in this paper also supports management of successful aquaculture practices. | | | | | |
| **Semester** | 3 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge on various organs and organ systems of an organism | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Explain the digestive system and process of digestion in fin fishes and shell fishes. | U | 1,2,10 |
| 2 | Summarize the circulatory and respiratory systems of fin fishes and shell fishes | U | 1,3 |

| | | | |
|---|---|---|---|
| 3 | Utilize the knowledge on excretory, reproductive and nervous system of finfishes and shellfishes | A | 10 |
| 4 | Compare the food and feeding habits of fin fishesand shell fishes | U | 1,2 |
| 5 | Estimate the age and growth of fishes by various methods | C | 3 |
| 6 | Examine and Analyzevarious organs and organ systems of finfishes and shellfishes | An | 1,2,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | **Digestive system of fin fishes and shell fishes 15 Hrs. Circulatory and respiratory system of finfishes and shellfishes** | | | |
| | 1.1 | Structure of digestive system of finfish<br>Associated digestive gland and their functions<br>Digestive system of Shrimp and Bivalve | 5 | 1 |
| | 1.2 | 1. Structure of heart, blood vascular system of finfishes and Bivalves | 4 | 1 |
| | 1.3 | Gills and process of respiration in finfishes<br>Accessory respiratory organsof finfishes. | 3 | 1 |
| | 1.4 | 2. Swim bladder<br>Swimming activity, Social behaviour and migration in fishes | 3 | 1 |
| | **Excretory, reproductive and nervous system<br>Food and feeding habits of finfishes and shell fishes 15 hrs** | | | |

| | | | | |
|---|---|---|---|---|
| 2 | 2.1 | Excretory organs in finfish, their physiological functions and mechanism of excretion.<br>Osmoregulation in finfishes. Endocrine control of osmoregulation.<br>Excretory organs and physiology of excretion in shell fishes – shrimps, bivalves | 5 | 3 |
| | 2.2 | Structure and physiology of reproductive system of finfishes.<br>. Structure and physiology of reproductive system of shrimp and crab | 3 | 3 |
| | 2.3 | Nervous and lateral line system, sense organs (eye, ear, olfactory organs) of finfishes. | 4 | 3 |
| | 2.4 | Natural food of fishes.<br>Feeding habits and types of feeding in fishes- Carnivorous, Herbivorous and Omnivorous, Predators, Grazers, Suckers, Strainers and parasites.<br>Feeding habits and method of feeding in shell fishes (Shrimp, bivalve, cephalopod). | 3 | 4 |
| 3 | **Age and growth studies of fish** **15 Hours** | | | |
| | 3.1 | Growth of finfishes- Absolute and relative growth, isometric growth and allometric growth. The cube law. | 3 | 5 |
| | 3.2 | Methods for determination of growth checks. Length frequency analysis. Analysis of growth using hard parts like scales, otoloiths and vertebrae. | 3 | 5 |
| | 3.3 | Estimation of growth by direct methods. Marking and tagging of fish for growth studies. | 3 | 5 |
| | 3.4 | Methods of studying reproduction Maturity Stages, Gonadosomatic Index, Ova Diameter Frequency studies. | 3 | 5 |
| | 3.5 | Determination of size at first maturity and spawning season, Fecundity and its determination. | 3 | 5 |
| 4 | **PRACTICAL** **30 Hours** | | | |
| | 1 | Dissect and study the digestive system of fin fishes | 4 | 6 |
| | 2 | Structure of gills of finfishes<br>(Herbivore, omnivore, carnivore) | 4 | 6 |
| | 3 | Gut content analysis of finfishes | 4 | 6 |

| | | | | |
|---|---|---|---|---|
| | 4 | Nervous system of prawn | 4 | 6 |
| | 5 | Study of gill structure of crustacean | 2 | 6 |
| | 6 | Study of gill structure of bivalve | 2 | 6 |
| | 7 | Dissect and understand the reproductive organs of finfishes | 4 | 6 |
| | 9 | Familiarize various types of tags used in age and growth studies | 2 | 6 |
| | 10 | Analysis of length frequency data | 4 | 6 |

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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |



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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Seaweed Culture and Utilisation** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG3DSEAQC200** | | | | | |
| **CourseLevel** | **200** | | | | | |
| **Course Summary** | Seaweeds are macroscopic algae that grow in marine, shallow coastal waters and on rocky shores and have emerged as a topic of interest in aquaculture owing to their wide application potentials. They are a new renewable source of food, energy, chemicals, and medicines with manifold nutritional, industrial, biomedical, agriculture, and personal care applications. Though the industrial application of seaweed is on the rise there is a short supply of raw materials to meet the demands. In this scenario seaweed culture and its supply to the industry is of a high demand. The course covers topics such as seaweed identification, introductory seaweed culture techniques, propagative methods and its product utilization possibilities. | | | | | |
| **Semester** | **3** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | **3** | | **1** | | **75** |
| **Pre- requisites, if any** | Knowledge about general resources from the oceans and seas is desirable. | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Classify the economically important sea weeds. | **U** | **2,10** |

| | | | |
|---|---|---|---|
| 2 | Prepare the students for the culture of the economically important seaweeds. | **C** | **1,2, 3,6,10** |
| 3 | Utilize the seaweeds for the extraction of different products. | **U, A** | **1,2, 10** |
| 4 | Understand the reproduction and lifecycle of the seaweeds. | **U** | **1,2,3,6, 10** |
| 5 | Develop skill to scientifically identify seaweeds. | **U, S** | **1,2, 4, 10** |
| 6 | Identify the reproductive bodies of seaweed. | **S, I, U** | **1, 2,6, 10** |

***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Taxonomy, Morphology and Reproduction of economically important seaweeds.** | | **17 Hours** | |
| | 1.1 | **Green Algae** (Chlorophyceae): *Enteromorphacompressa, Monostroma*<br>**Brown Algae** (Phaeophyceae): *Undariapinnatifida, Laminaria* spp.<br>**Red Algae** (Rhodophycea): *Porphyra*spp | **9** | **1, 5** |
| | 1.2 | **Reproduction and life cycle**<br>Sexual and asexual reproduction methods. Different propagation methods of seaweeds. | **8** | **4, 6** |
| **2** | **Seaweed culture in India** | | **14 Hours** | |
| | 2.1 | Distribution of seaweeds in Indian coast. | **2** | **2, 3** |
| | 2.2 | Criteria for selecting a good site in open waters and in seawater ponds for seaweed culture. | **2** | **2, 3** |
| | 2.3 | Growth of seaweeds and factors affecting growth pattern, environmental monitoring, causes of mortality. | **4** | **2, 3** |
| | 2.4 | Small scale, commercial scale and recent developments in culture operations. Types of | **6** | **2, 3** |

| | | | | |
|---|---|---|---|---|
| | | seaweed culture -Fixed off bottom culture: Floating raft/cage culture: Bottom culture: Greenhouse culture: Spray culture: Raceway culture; IMTA-Integrated multi trophic aquaculture | | |
| **3** | **Utilization of seaweeds** | | **14 hours** | |
| | 3.1 | Post – harvest technology of cleaning, washing and storage. | **2** | **3** |
| | 3.2 | Chemical composition of seaweed. | **4** | **3** |
| | 3.3 | Processing and extraction of algin, alginic acid and alginates, processing and extraction of agar, mannitol and carrageen. | **6** | **3** |
| | 3.4 | Application of seaweeds as Pharmaceuticals. | **2** | **3** |
| **4** | **Practicals** | | **30 Hours** | |
| | 4.1 | Identification of economically important seaweeds and their reproductive bodies. | **4** | **1,6** |
| | 4.2 | Identification/preparation of culture models. | **4** | **1,2** |
| | 4.3 | Field study of distribution and zonation of sea weeds, collection of sea weed material. | **8** | **1,2,5,6** |
| | 4.4 | Visit to a Research Institution untaken seaweed culture | **6** | **1,2,5,6** |
| | 4.5 | Visit to a Seaweed processing industry | **8** | **1,2,5,6** |
| **5** | **Teacher Specific Content** | | | |

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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks |

| | |
|---|---|
| | • Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Aquatic Ecology, Water and Soil Quality Parameters** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG3DSEAQC201** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course explores the fundamental principles of aquatic ecology, soil science, and the assessment of water quality parameters. Emphasis is placed on understanding the interrelationships between aquatic ecosystems, soil composition, and various water quality parameters, with a focus on monitoring and managing environmental health. Practical exercises, field trips, and hands-on projects can further enhance the learning experience for students in this course | | | | | |
| **Semester** | 3 | Credits | | | 4 | |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | Total Hours |
| | | 3 | | 1 | | 75 |
| **Pre- requisites, if any** | Students from diverse backgrounds, including biology, environmental science, chemistry, geology, or related disciplines, may find this course relevant to their academic interests and career goals.Even if they don't match the requirements, students who are really interested in the subject could still be eligible to enrol. | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domain s | PO No |
|---|---|---|---|
| 1 | Understand the fundamental principles of aquatic ecology,soil science and explain the interconnections between them. Apply the ecological concepts to analyze andinterpet the dyanamics of various aquatic ecosystems. | U,An | 1,5,6 |
| 2 | Apply standard methods and instrumentation for the measurement and analysis of physicochemical parameters in water samples. | A | 1,3, |
| 3 | Analyse the relationships between biological parameters and environmental factors and to evaluate the role of bio-indicators in detecting the health of aquatic ecosystems. | An | 1,6 |
| 4 | Proficiency in using variety of equipments and instruments for field sampling. | C,S | 1,2 |
| 5 | Evaluate the emerging issues of water quality and ecosystem health. | E,An | 1,6 |
| 6 | Develop fundamental skills in doing the water and soil quality parameters. | A, S | 1,9 |
| ***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |



## COURSE CONTENT

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to Aquatic Ecology and principles of soil science** | | **15 Hours** | |
| | 1.1 | Definition and scope of aquatic ecology. Key aquatic ecosystems (lakes, oceans, rivers, wetlands). | 2 | 1 |

| | | | | |
|---|---|---|---|---|
| 1 | 1.2 | Pond Ecology – Physico chemical characteristics of pond, zonation/stratification, Abiotic and biotic components, food chain in pond ecosystem. | 2 | 1 |
| | 1.3 | Riverine Ecology - Physico chemical characteristics of river, zonation/stratification, Abiotic and biotic components, food chain in riverine ecosystem, Adaptations of lotic animals. | 3 | 1 |
| | 1.4 | Marine, Estuarine and Brackish water Ecology - Physico chemical characteristics, Zonation, zonation/stratification, Abiotic and biotic components, food chain in marine, estuarine and brackish water ecosystem. Characteristics of Coral reef community. Classification of estuaries | 3 | 1 |
| | 1.5 | Lacustrine and Reservoir Ecology - Classification of lakes, Zonation / Stratification in lakes, Abiotic and biotic components, Biological communities of lakes.Major lakes and reservoirs in Kerala and India, Effects of dams. | 3 | **1** |
| | 1.6 | • Soil formation, composition and physico-chemical properties. | 2 | **1** |
| | **Water Quality Parameters(Physico-chemical & Biological)** | | **15Hours** | |
| **2** | 2.1 | Introduction to water quality assessment<br>• **Activity** – checking the water quality of nearby water bodies. | 3 | 2,6 |
| | 2.2 | Physical parameters (temperature,salinity, turbidity) | 3 | 2,6 |
| | 2.3 | Chemical parameters (pH, dissolved oxygen, ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen) | 3 | 2,6 |
| | 2.4 | Aquatic micro/macroinvertebrates as bioindicators (phytoplankton,zooplankton,benthos, HAB (Harmful Algal Bloom). | 3 | 3 |
| | 2.5 | Role of phytoplankton and zooplankton abundance in water quality assessment; Fish and their role in ecosystem health. | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| **3** | **Methods of monitoring water / soil Quality &emerging issues in aquatic ecology** | | | **15 hrs** |
| | 3.1 | Sampling techniques for water and soil Soil –Random sampling, Grid sampling,<br>Zone sampling<br>Water - Random sampling, Systematic sampling, Haphazard sampling, Stratified random sampling, Judgemental(sampling) | 3 | 4 |
| | 3.2 | Laboratory analysis of water quality parameters Physical parameters (temperature, salinity, turbidity) – Standard methods<br>Chemical parameters (pH, dissolved oxygen, ammonia-nitrogen, nitrite-nitrogen, nitrate-nitrogen) - Standard methods. | 4 | 4 |
| | 3.3 | Field measurements and instrumentation – Water sampler, grab, plankton net, pH meter, refractometer, thermometer, secchi disc). | 4 | 4,6 |
| | 3.4 | Microplasticpollutioin, **Pharmaceutical Contaminant;** Emerging pathogens and Harmful Algal Blooms HABs | 4 | 5 |
| | | **PRACTICAL 30 Hours** | | |
| 4 | 4.1 | Estimation of $p^H$ water samples | 6 | |
| | 4.2 | Estimation of turbidity of water samples , Estimation of salinity, Alkalinity | 6 | |
| | 4.3 | Estimation of dissolved oxygen , $CO_2$ and BOD | 4 | |
| | 4.4 | Aquatic macro and micro invertebrates and algae. | 6 | |
| | 4.5 | Familiarisation with water and soil sampling Equipments and Methods.<br>Random, Grid and Zone sampling of soil and water. | 8 | |
| 5 | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Reproductive Biology and Endocrinology** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG3DSEAQC202** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | Reproductive physiology of finfishes as well as shellfishes is a vast scientific field, which directly concerns a set of physiological processes essential for reproduction, beginning with egg fertilization and ending with sexual behaviour and spawning. As endocrine system regulates gonadal development, growth, and reproduction, fish endocrinology has been the focus of various studies for basic understanding of these physiological events and for advances in aquaculture. Fish seed collections from the natural site of spawning possess problems of being mixed with spawns of predaceous fishes. Even though much care is taken in identifying the fish seed by adopting various methods, their separation sometime becomes difficult. To overcome these difficulties, induced breeding has been developed. This technique assures a timely available supply of seed spawn for fish culture. | | | | | | |
| **Semester** | 3 | Credits | | | 4 | |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | Total Hours |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge of reproductive organs and endocrine glands | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | 1. Understand the various reproductive techniques in finfishes and shellfishes and the factors controlling reproduction. | U | 2,9 |

| | | | |
|---|---|---|---|
| 2 | Introduce the endocrine and neurosecretory system of finfishes and shellfishes. | U | 1,10 |
| 3 | Develop skill on the techniques of induced breeding of fin fishes and shellfishes<br>Activity : Visit to any private or government fin fish hatchery and learn induced breeding technique of fin fishes/ shrimp | S | 2 |
| 4 | Choose different anesthetics used in fish reproduction | R | 2,10 |
| 5 | Outline the basics of embryology of fishes | U | 1,3,9 |
| 6 | Develop fundamental skills in reproductive biology and induced breeding techniques | A, S | 10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Reproductive system and modes of reproduction** | | **15 Hrs** | |
| 1 | 1.1 | Reproductive systems and Sexual dimorphism in fish, crab and prawn | 3 | 1 |
| | 1.2 | Types of reproduction : Viviparity, ovoviviparity, oviparity in Teleosts and Elasmobranchs. | 3 | 1 |
| | 1.3 | Classification of maturity stages of ovary and testes in fishes and prawns. | 1 | 1 |
| | 1.4 | Oogenesis and spermatogenesis in fishes. | 5 | 1 |
| | 1.5 | Hermaphroditism- different types. Sex reversal and sex determination in fishes. | 3 | 1 |
| 2 | **Neurosecretory and endocrine systems of finfishes** | | **15 Hours** | |

| | | | | |
|---|---|---|---|---|
| | 2.1 | Organisation, structure and Functions of Neurosecretory and endocrine systems in fin fishes. tuitary, Thyroid, Chromaffin tissue, Interrenal tissue, Pancreatic islets, Corpuscles of Stannius, Ultimobranchial Glands, Gonads, Gastro-intestinal Hormones, Pineal organ, Caudal neurosecretory system or Urophysis. | 10 | 2 |
| | 2.2 | Neuroendocrine control of reproduction. Role of Hypothalamus - Pituitary – Gonadal axis in control of maturationin fishes | 2 | 2 |
| | 2.3 | Gonadotropin releasing hormones, gonadotropins and sex steroids. | 3 | 2 |
| | 2.4 | Neuroendocrine systems in crustaceans and control of reproduction. Sinus gland complex and X- organs. Pericardial and Post-commisural organs. True Endocrine organs-Y- organs, androgenic gland and Mandibular organs | 5 | 3 |
| | 2.5 | Hormones produced by the neuroendocrine and true endocrine glands and their role in the control of reproduction and moulting in Crustaceans. Parasitic castration | 5 | 3 |
| 3 | **Induced breeding techniques ,Cryopreservation and Embryonic Development of Fishes, Eyestalk Ablation** | | **20 hrs** | |
| | 3.1 | Principles of induced maturation and spawning in fishes and crustaceans.<br>Levels of control in induced breeding and maturation in fishes.<br>Environmental control of reproduction in fishes and prawns. | 2 | 4 |
| | 3.2 | Use of hormones and hormone analogues in fishes- Gonadotropin releasing hormones, Gonadotropins and Sex steroids.<br>Methods of hormonal administration.<br>Hypophysation, Linpe Method, Ovaprim.<br>Eyestalk ablation- Its principle and application in crustacean hatcheries. | 3 | 4 |
| | 3.3 | Anaesthetics, Pharmaceutical and Non – Pharmaceutical Methods of Anaesthesia and their use in Fish Breeding and Handling<br>Use of hormones for producing monosex population and sex reversal in fishes. | 2 | 4 |

| | | | | |
|---|---|---|---|---|
| | 3.4 | Principles and methods of cryopreservation of gametes | 2 | 5 |
| | 3.5 | Types of eggs in fishes – Pelagic, Demersal and according to yolk content.<br>. Embryonic development- Cleavage, fate map of Blastula, gastrulation- Invagination, Involution, Delamination, Convergence, Epiboly. Hatching Post Embryonic development and Larval development. | 3 | 5 |
| **4** | **PRACTICALS** | | **30 Hrs** | |
| | 4.1 | Dissection of Reproductive organs of Teleost Fish | 6 | 6 |
| | 4.2 | Identification of Maturity Stages in Teleost Fish | 6 | 6 |
| | 4.3 | Sexual Dimorphism in Teleost Fishes , Prawns and Crabs | 4 | 6 |
| | 4.4 | Estimation of Fecundity and Gonadosomatic Index | 6 | 6 |
| | 4.5 | Identification of embryonic and larval Stages of Fishes | 4 | 6 |
| | 4.6 | Larval stages of Prawns , Crabs and Lobsters | 2 | 6 |
| | 4.7 | Identification of equipments in electrocauterisation and Cryopreservation | 2 | 6 |

| | | |
|---|---|---|
| 5 | **Module 5: Teacher Specific Content** | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | | | | | | |
| **Course Name** | **Fishery Byproducts and Value Addition** | | | | | |
| **Type of Course** | **MDC** | | | | | |
| **Course Code** | **MG3MDCAQC200** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course explores the various byproducts generated in the fishing industry and focuses on value addition through processing techniques, creating sustainable practices, and developing innovative products from fishery byproducts. | | | | | |
| **Semester** | 3 | Credits | | | 3 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | | | 45 |
| **Pre-requisites, if any** | Students should attain knowledge regarding value added product development in Seafood sector. | | | | | |



**COURSE OUTCOMES (CO)**

| CO. No. | Expected Course Outcome | Learning Domain | PO No |
|---|---|---|---|
| 1 | Identify fishery byproducts and understand market trends, present status and distribution of value-added seafood products and consumer preferences. | U, An | 1,4 |
| 2 | Explain the technical preparation of fish mince based products with special emphasis on surimi production. | E, An | 1,2,6 |

| | | | |
|---|---|---|---|
| 3 | Explain the preparation, packaging and storage as well as quality evaluation of coated fishery products. | E,U | 1,2,5 |
| 4 | Summarize the preparation of a number of other value added products such as pickles, wafers, chutney powders, steaks, cutlets etc, from fish or shrimp. | U,I | 1,6 |
| 5 | Apply principles of sensory evaluation to assess product quality and study the characteristics of fish, its nutritional quality and relation to spoilage. | A,S | 1,8,9 |
| 6 | Develop to prepare by-products like chitin, chitosan, fish silage, fish meal, fish oil etc. for commercial gain. | C,A | 4,5,10 |
| | ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Value Addition in Seafoods** | | **6hrs** | |
| | 1.1 | Overview of Value added products; Present market trends and consumer preferences, Scope of value addition. | **3** | 1 |
| | 1.2 | Status of value addition in Indian seafood sector, Types of value added products.<br>Significance and advantages of value addition in the seafood industry. | **3** | 1 |
| **Fish Mince based Products, Coated fishery products and other Value Added Products** | | | **22 Hrs** | |
| 2 | 2.1 | Definition of Fish mince and Surimi. Raw materials used for surimi.<br>Production of fish mince and Surimi including Flow chart | 4 | 2 |
| | 2.2 | Fibreized and other products from Fish Mince | 4 | 2 |

| | | | | |
|---|---|---|---|---|
| | 2.3 | Equipments used for surimi preparation.<br><br>Different methods in assessing quality of surimi.<br><br>Define cryoprotectants. Role of different cryoprotectants in surimi production. | 5 | 2 |
| | 2.4 | Definition of coated fishery products and its preparation.<br><br>Battered and breaded fishery products and its applications. | 4 | 2 |
| | 2.5 | Preparation of products viz. fish / prawn pickle, fish wafers, prawn chutney powder, fish soup powder, fish protein hydrolysate, fish stacks, fillets, marinated products. | 5 | 3 |
| | **Fishery By-products, Quality Control and Safety in Value Added Products** | | **17 hrs** | |
| 3 | 3.1 | Production of chitin, chitosan and glucosamine hydrochloride from shrimp shell waste.<br><br>Definition of fish silage, Types of fish silages and their preparation. Uses of silage. | 5 | 5,6 |
| | 3.2 | Isinglass, shark fin rays, gelatin from fish waste. Ambergris, beche-de-mer, squalene, fish meal and oil. | 4 | 5,6 |
| | 3.3 | Seaweed products - agar, alginic acid and carrageenan.<br><br>Extraction of collagen from fish processing wastes, properties and application. | 4 | 6 |
| | 3.4 | Spoilage in thermal processed products – Quality evaluation of thermal processed products<br><br>Curing and drying of fish – Spoilage in dry fish products | 4 | 5 |
| 4 | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>Theory – 25 Marks |
| | |

| | |
|---|---|
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks |

## REFERENCES


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| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | | | | | | |
| **Course Name** | **Aquatic Pollution and Management** | | | | | |
| **Type of Course** | **VAC** | | | | | |
| **Course Code** | **MG3VACAQC200** | | | | | |
| **CourseLevel** | **200** | | | | | |
| **Course Summary** | The course is designed to expose undergraduate students to various dimensions of aquatic pollution, resulting environmental and public health hazards, and various tools available for monitoring and reduction of pollution. It covers the classification of aquatic pollution, sources of pollution, and types of pollution, the methods for evaluation and management of water quality of aquatic bodies and its physical, chemical, and biological pollutions. | | | | | |
| **Semester** | **3** | Credits | | | **3** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | **3** | | | | **45** |
| **Pre- requisites, if any** | Students should possess knowledge regarding water bodies. | | | | | |



**COURSE OUTCOMES (CO)**



| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understand the sources of aquatic pollutants. | **U** | **1,2, 9, 10** |
| 2 | Outline the different types of contaminants. | **U** | **1,2, 10** |
| 3 | Explain the microbial impacts on environment. | **U** | **1,2, 10** |
| 4 | Categorize the pollutants and it remedial measures | **An** | **1,2,3,6** |
| 5 | Utilise the principles of bioremediation for management of aquatic pollution. | **A** | **1,2, 6, 10** |

| | | | |
|---|---|---|---|
| 6 | Develop interest in the public on the management of aquatic pollution. | **I,A, S** | **1, 2,6, 10** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to aquatic pollution** | | **8 Hours** | |
| | 1.1 | Introduction& Definition | **2** | **1** |
| | 1.2 | Sources of pollutants | **2** | **1** |
| | 1.3 | Toxic organic compounds and their impacts in the aquatic organisms | **2** | **1** |
| | 1.4 | Physical, chemical and biological classification of water pollution. | **2** | **1** |
| **2** | **Types of pollution & its effects on aquatic environment , Eutrophication** | | **13 Hours** | |
| | 2.1 | Sewage and domestic wastes, Agricultural Waste, Pesticides, Heavy Metal Pollution | **2** | **2** |
| | 2.2 | Oil , Thermal, Radioactive and Microbial Pollution | **3** | **2** |
| | 2.3 | Major and minor nutrients and their concentration in eutrophicated water – Categories - Eutrophic &Oligotrrophic; -Anthropogenic & Natural | **2** | **2,3** |
| | 2.4 | Organic detritus & nutrients, BOD, COD. | **2** | **2,3** |
| | 2.5 | Red Tides and its causes, Algal Blooms in Indian waters | **4** | **2,3** |
| **3** | **Monitoring and control of pollution, Bioremediation and Phytoremediation** | | **24 Hours** | |
| | 3.1 | Laws related to water pollution in India , Water Quality Index | **2** | **4** |
| | 3.2 | Biological indicators of pollution | **2** | **4** |
| | 3.3 | Solid waste management | **2** | **4** |

| | | | | |
|---|---|---|---|---|
| | 3.4 | Principles and factors of Bioremediation and Phytoremediation | **2** | **5** |
| | 3.5 | Bioremediation and phytoremediation strategies. Advantages and disadvantages of bioremediation and phytoremediation | **4** | **5** |
| | 3.6 | Activity – any 2<br><br>1. Physical characteristics of polluted waters. Prepare a report.<br>OR<br>Visit to a sewage treatment plant/ waste dumping site. Prepare a report<br><br>2. Beach cleaning - Solid waste removal from beaches. Prepare a report.<br>OR<br>Solid waste removal from any aquatic ecosystem. Prepare a report. | 12 Hrs | |
| **Module 4** | | **Teacher Specific Content** | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>Theory – 25 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (5 out of 9) 5 X 5 = 25 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Report Submission – 5 Marks<br>• Total – 50 Marks |

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# SEMESTER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Nutrition and Feeding of Fishes** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG4DSCAQC200** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | Fish nutrition is crucial for ensuring healthy growth of fish and optimizing aquaculture practices.This course gives an insight into the basics of fish nutrition, bioenergetics, feed ingredients, feed formulation, quality control and feed management system to equip the student for sustainable aquaculture practices. | | | | | |
| **Semester** | 4 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre- requisites, if any** | Students should possess basic knowledge regarding fishes and nutrients in various food groups. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Comprehends the application of nutrition principles in aquaculture practices, focusing on enhancing growth, reproduction, and overall health of farmed fish through optimized feeding regimes. | U | 1,2 |
| 2 | Estimates the energy budgets in fish by exploring the bioenergetics of fish nutrition, including the processes of energy acquisition, utilization, and allocation within fish metabolism. | An | 1,2 |

| | | | |
|---|---|---|---|
| 3 | Identify the feed ingredients and formulate an ideal fish feed considering protein, lipid, and carbohydrate sources, to optimize feed conversion ratios. | A | 1,2,3 |
| 4 | Develops skill in feed manufacture and ensure its quality by practices that minimize feed wastage, contamination, and degradation during storage and distribution. | S | 1,2,6 |
| 5 | Acquires understanding of the feed management sytems in aquaculture. | U | 1,2 |
| 6 | Identify nutritional deficiencies and disorders in fish, and learn approaches for preventing and managing these conditions through proper dietary adjustments and supplementation. | An | 1,2 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Nutritional requirements and energetics of cultivable fishes.** | **15 Hours** | | |
| 1 | 1.1 | Major nutrients: Carbohydrate, protein, lipid, vitamin, mineral and micronutrients | 4 | 1 |
| | 1.2 | Nutritional requirements of various stages of fish- larvae, juveniles and adults. | 2 | 1 |
| | 1.3 | Bioenergetics, gross energy, Intake energy, Faecal energy, Urinary energy,digestible energy, metabolizable energy, Total heat production, net energy, specific dynamic action (SDA), retained energy<br>Factors affecting digestibility, factors affecting energy requirement of fish, nitrogen balance index . | 5 | 2 |
| | 1.4 | Gross conversion efficiency, Feed conversion ratio, SGR, feed conversion efficiency, protein efficiency ratio<br>Measurement of calorific value- Component Analysis, Wet oxidation, Bomb Calorimetry | 4 | 2 |
| | **Feed formulation** | **15 Hours** | | |

| | | | | |
|---|---|---|---|---|
| | 2.1 | General principles of feed formulation, different methods of feed formulation – Pearson's square method, Linear programming. | **5** | **4** |
| | 2.2 | Types of feeds – wet, moist dry (pellet-steam compressed, extruded and crumbles, flakes, powdered, microencapsulated, microcoated diet) | **3** | **4** |
| | 2.3 | Farm feed, Starter, grower, finisher and broodstock feed. | **2** | **4** |
| | 2.4 | Feed manufacture- Grinding, Mixing, Pelleting, Equipments used in feed manufacture and processing; weighing scales,Grinder/pulverizer, Mixer, Pelletizer/extruder, Crumbler, sifter,Drier, Vacuum coater/ fat sprayer ,bag seamer. | 3 | 4 |
| | 2.5 | Economics of feed preparation | 2 | 4 |
| | **Feed Ingredients and feed management** | | **15 Hours** | |
| 3 | 3.1 | Ingredient classification: Conventional and unconventional feed ingredients( Plant and animal sources)Quality evaluation of feed ingredients. Physical, Chemical and Biological, non nutrient components of the diet | 4 | 3 |
| | 3.2 | Feed additives and supplements and their functions(Binders, antioxidants, chemoattractants, feeding stimulants, pigments, antimicrobial agents ,anabolic agents and growth promoters) | 3 | 3 |
| | 3.3 | Feed storage- Microbial damage, insect, rodent damage, chemical changes during storage. Fungus and associated toxins | 2 | 3 |
| | 3.4 | Ration size/feeding rate and feeding frequency,Record keeping,Nutritional deficiency disorders, symptoms and diseases in fishes-Fish scurvy,Lipidosis,Avitaminosis,Thiamin deficiencies. | 3 | 5,6 |
| | 3.5 | Feeding methods and devices: Broadcasting, Bag feeding, Tray feeding, Raft feeding, demand feeder, Mechanical automatic feeder, Blower feeder. Check tray feed monitoring. | 3 | 5 |
| | **4. Practical** | | **30 Hours** | |
| 4 | 1 | Gut content analysis to study natural food in fish | 3 | 6 |

| | | | | |
|---|---|---|---|---|
| | 2 | Qualitative analysis of carbohydrate, lipid and protein. | 3 | 6 |
| | 3 | Pearson's square to formulate a feed of desired nutritional quality | 3 | 6 |
| | 4 | Study of identification feed ingredients of plant origin (oil cakes and meals eg: Groundnut oil cake, coconut oil cake, Mustard oil cake) | 3 | 6 |
| | 5 | Study of identification feed ingredients of animal origin(Fish meal, Crustacean meals, Molluscan meals, Blood meal etc) | 3 | 6 |
| | 6 | Identification of non-conventional feedseg. Spirulina etc. and Feed Additives (Binders, Antibiotics etc). | 3 | 6 |
| | 7 | Study of feeding methods/devices | 3 | 6 |
| | 8 | Study of equipment used in manufacture of fish feeds ((Oven, Pelletiser, Feed Press and Die Plate, Extruders etc.) | 3 | 6 |
| | 9 | Formulation of artificial feed for aquarium fishes and prawns with locally available ingredients | 3 | 6 |
| | 10 | Visit to an aquaculture farm to study feeding practices | 3 | 6 |
| 5 | Teacher specific Content | | | |



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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks |

| | |
|---|---|
| | • Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Taxonomy and Morphology of shell fishes** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG4DSCAQ C201** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course focuses on the systematic study of shellfish, emphasizing their taxonomy, classification, and morphological characteristics. Students will gain a thorough understanding of the diversity within the shellfish group and develop skills in identifying and classifying different species based on morphological features. | | | | | |
| **Semester** | 4 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | | | | 60 |
| **Pre-requisites, if any** | Students from diverse backgrounds, including biology, environmental science, chemistry, geology, or related disciplines, may find this course relevant to their academic interests and career goals. | | | | | |



## COURSE OUTCOMES (CO)

| CO No | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understand the fundamental principles of taxonomy | U, | 1 |
| 2 | Analyse the role of morphological characteristics in classical taxonomy and its integration with modern molecular approaches. | An,A | 1,3 |
| 3 | Understand and develop fundamental skills in identification of bivalve molluscs. | U,S | 1,5 |

| | | | |
|---|---|---|---|
| 4 | Understand and Develop fundamental skills in identification of gastropod molluscs. | U,S | 1,5 |
| 5 | Understand and Develop fundamental skills in identification of economically important crustaceans. | U,S,An | 1,5 |
| 6 | Evaluate the importance of blending classical and molecular taxonomy. | E,C | 5,6 |
| ***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Principles of taxonomy** | **10 Hours** | | |
| 1 | 1.1 | Basic principles of biological classification | 2 | 1 |
| | 1.2 | Kinds of classification- Phenetic, natural, cladistics, evolutionary and ominispective classification. | 2 | 1 |
| | 1.3 | Concept of species; Kinds of species-allopatric, sympatric, insular, panmictic and apomictic, and polytypic species | 3 | 1 |
| | 1.4 | International Code of Zoological Nomenclature; kinds of names- tautonyms, synonymy, homonymy.Typification, type and its kinds - primary types eg:holotype, lectotype and paratype, syntype, neotype | 3 | 1 |
| | **Introduction to shellfish & Bivalve Morphology and Taxonomy** | **20 Hours** | | |
| **2** | 2.1 | Classification of phylum mollusca upto class' | 3 | 2 |
| | 2.2 | Traditional taxonomy methods of bivalve, cephalopods and crustaceans. | 3 | 2,6 |
| | 2.3 | • Molecular techniques in shellfish classification- DNA barcoding technique- procedure- region amplified-primer used ( any mollusc) | 4 | 2,6 |

| | | | | |
|---|---|---|---|---|
| | 2.4 | • Systematic position of bivalve molluscs | 3 | 3,6 |
| | 2.5 | • Morphological characteristics of bivalves<br>Activity:<br>1. Identify bivalves from your neighborhood aquatic systems<br>2. Dichotomous Key Identification of commercially important bivalves | 4 | 3,6 |
| | 2.6 | • Ecological roles (Biofouling and Shellfish poisoning)<br>• and economic importance of commercially important bivalves (Pecten,Crassostrea madrasensis, Perna viridis, Pinctada fucata, Scallops) | 3 | 2,6 |
| **Gastropod and cephalopod taxonomy and morphology 15Hours** | | | | |
| 3 | 3.1 | Classification of gastropod and cephalopod mollusks and characters<br>**Activity:**<br>1. Cephalopod Morphology:<br>(Examination of preserved cephalopod specimens. Identification of key features such as tentacle arrangement, eye structure, and mantle characteristics). | 5 | 4,6 |
| | 3.2 | Morphological characteristics of gastropods and cephalopod<br>Activity:<br>1. Identify a gastropods and cephalopods from your neighborhood aquatic system<br>2. Dichotomous Key Identification of commercially important gastropods | 5 | 4,6 |
| | 3.3 | • Torsion in gastropods,economic importance of commercially important gastropods and cephalopods (Unio, Pila globosa,Teredo, Sepia, Loligo, Octopus, Nautilus) | 5 | 4,6 |
| 4 | Crustacean Taxonomy and Morphology 15 Hrs | | | |
| | 4.1 | Morphological characteristics of major crustacean groups-P. indicus , Scylla serrata and Panulirus homarus<br>**Activity:** | 10 | 5,6 |

| | | | | |
|---|---|---|---|---|
| | | 1.Identify crustaceans from your neighborhood aquatic system<br>2. Dichotomous Key Identification of commercially important crustaceans<br>3. Mount the appendages of prawn | | |
| | 4.2 | Ecological diversity and economic significance of Crustacea<br>• Activity:<br>• 1.Identification of larval stages of Crustaceans and Molluscs. | 5 | 5.6 |
| 5 | **Teacher Specific Content** | | | |

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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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|---|---|
| **Programme** | **BSc (Hons) Aquaculture** |
| **Course Name** | **Reproductive Physiology, Endocrinology and Induced breeding Techniques** |
| **Type of Course** | **DSC C** |
| **Course Code** | **MG4DSCAQC202** |
| **Course Level** | **200** |
| **Course Summary** | Reproductive physiology of finfishes as well as shellfishes is a vast scientific field, which directly concerns a set of physiological processes essential for reproduction, beginning with egg fertilization and ending with sexual behaviour and spawning. As endocrine system regulates gonadal development, growth, and reproduction, fish endocrinology has been the focus of various studies for basic understanding of these physiological events and for advances in aquaculture. Fish seed collections from the natural site of spawning possess problems of being mixed with spawns of predaceous fishes. Even though much care is taken in identifying the fish seed by adopting various methods, their separation sometime becomes difficult. To overcome these difficulties, induced breeding has been developed. This technique assures a timely available supply of seed spawn for fish culture. |

| **Semester** | 4 | Credits | | | 4 | Total Hours |
|---|---|---|---|---|---|---|
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge of reproductive organs and endocrine glands | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | 2. Understand the various reproductive techniques in finfishes and shellfishes and the factors controlling reproduction. | U | 2,9 |
| 2 | Introduce the endocrine and neurosecretory system of finfishes and shellfishes. | U | 1,10 |

| | | | |
|---|---|---|---|
| 3 | Develop skill on the techniques of induced breeding of fin fishes and shellfishes<br>Activity : Visit to any private or government fin fish hatchery and learn induced breeding technique of fin fishes/ shrimp. | S | 2 |
| 4 | Choose different anesthetics used in fish reproduction | R | 2,10 |
| 5 | Outline the basics of embryology of fishes | U | 1,3,9 |
| 6 | Develop fundamental skills in reproductive biology and induced breeding techniques | A, S | 10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Reproductive system and modes of reproducti** **15 Hrs** | | | |
| 1 | 1.1 | Reproductive systems and Sexual dimorphism in fish, crab and prawn. | 3 | 1 |
| | 1.2 | Types of reproduction : Viviparity, ovoviviparity, oviparity in Teleosts and Elasmobranchs. | 3 | 1 |
| | 1.3 | Classification of maturity stages of ovary and testes in fishes and prawns. | 1 | 1 |
| | 1.4 | Oogenesis and spermatogenesis in fishes. | 5 | 1 |
| | 1.5 | Hermaphroditism- different types. Sex reversal and sex determination in fishes. | 3 | 1 |
| 2 | **Neurosecretory and endocrine systems of finfishes** **15 Hours** | | | |
| | 2.1 | Organisation, structure and Functions of Neurosecretory and endocrine systems in fin fishes. Pituitary, Thyroid, Chromaffin tissue, Interrenal tissue, Pancreatic islets, Corpuscles of Stannius, Ultimobranchial Glands, Gonads, Gastro-intestinal Hormones, Pineal organ, Caudal neurosecretory system or Urophysis. | 5 | 2 |

| | | | | |
|---|---|---|---|---|
| | 2.2 | Neuroendocrine control of reproduction. Role of Hypothalamus - Pituitary – Gonadal axis in control of maturationin fishes | 2 | 2 |
| | 2.3 | Gonadotropin releasing hormones, gonadotropins and sex steroids. | 3 | 2 |
| | 2.4 | Neuroendocrine systems in crustaceans and control of reproduction. Sinus gland complex and X- organs. Pericardial and Post-commisural organs. True Endocrine organs-Y- organs, androgenic gland and Mandibular organs | 2 | 3 |
| | 2.5 | Hormones produced by the neuroendocrine and true endocrine glands and their role in the control of reproduction and moulting in Crustaceans.<br><br>Parasitic castration | 3 | 3 |
| 3 | **Induced breeding techniques ,Cryopreservation and Embryonic Development of Fishes , Eyestalk Ablation 15 Hrs** | | | |
| | 3.1 | Principles of induced maturation and spawning in fishes and crustaceans.<br>Levels of control in induced breeding and maturation in fishes.<br>Environmental control of reproduction in fishes and prawns. | 3 | 4 |
| | 3.2 | Use of hormones and hormone analogues in fishes- Gonadotropin releasing hormones, Gonadotropins and Sex steroids.<br>Methods of hormonal administration. Hypophysation, Linpe Method, Ovaprim.<br>Eyestalk ablation- Its principle and application in crustacean hatcheries. | 3 | 4 |
| | 3.3 | Anaesthetics, Pharmaceutical and Non – Pharmaceutical Methods of Anaesthesia and their use in Fish Breeding and Handling<br>Use of hormones for producing monosex population and sex reversal in fishes. | 3 | 4 |
| | 3.4 | Principles and methods of cryopreservation of gametes | 3 | 5 |
| | 3.5 | Types of eggs in fishes – Pelagic, Demersal and according to yolk content.<br>Embryonic development- Cleavage, fate map of Blastula, gastrulation- Invagination, Involution, Delamination, onvergence, Epiboly. Hatching Post Embryonic development and Larval development. | 3 | 5 |
| **4** | **PRACTICALS** | | **30 Hrs** | |

| | | | | |
|---|---|---|---|---|
| | 4.1 | Dissection of Reproductive organs of Teleost Fish | 6 | 6 |
| | 4.2 | Identification of Maturity Stages in Teleost Fish | 6 | 6 |
| | 4.3 | Sexual Dimorphism in Teleost Fishes , Prawns and Crabs | 4 | 6 |
| | 4.4 | Estimation of Fecundity and Gonadosomatic Index | 6 | 6 |
| | 4.5 | Identification of embryonic and larval Stages of Fishes | 4 | 6 |
| | 4.6 | Larval stages of Prawns , Crabs and Lobsters | 2 | 6 |
| | 4.7 | Identification of equipments in electrocauterisation and Cryopreservation | 2 | 6 |

| | | |
|---|---|---|
| 5 | **Module 5: Teacher Specific Content** | |

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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Advanced Aquaculture Production Systems** | | | | | |
| **Type ofCourse** | **DSE** | | | | | |
| **Course Code** | **MG4DSEAQC200** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | The ultimate aim of any food production system is to increase the production levels in minimum space and time. This can be achieved either by genetically improving the ability to convert food to flesh of culture species or by using high efficiency feed or by improvement in the culture system, enabling stocking in high densities. This course aims to familiarize the student with the nuances of hi-tech aquaculture production systems including Biofloc technology, Recirculating Aquaculture systems, Aquaponics, as well as running water systems. This course also introduces the student to different types and methods of farming. | | | | | |
| **Semester** | **4** | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre- requisites, if any** | Students need to have an idea of the existing aquaculture practices and traditional systems of aquaculture. | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Evaluate the importance and role global aquaculture and understand the constraints and future prospects in Aquaculture | **E,U** | **1** |

| | | | |
|---|---|---|---|
| 2 | Understand the principles and systems of Biofloc | **U** | **2** |
| 3 | Evaluate and understand Recirculating Aquaculture Systems | **E,U** | **2** |
| 4 | Create an Aquaponics system; Understand water quality maintenance and Nutrient Recycling in Aquaponics systems | **C, U, E** | **1,2,9** |
| 5 | Understand significance of running water systems and raceways | **U** | **1,10** |
| 6 | Understand the concept of working of IMTA and PAS | **U** | **9,10** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction and overview of Aquaculture production** | | 5 Hrs | |
| | 1.1 | Overview of Global Aquaculture production | **1** | **1** |
| | 1.2 | Constraints and future prospects in Aquaculture production in India and around the world | **2** | **1** |
| | 1.3 | Types of farming systems – Cluster Farming, Organic Farming, Satellite Farming, Cooperative Farming | **1** | **1** |
| | 1.4 | Enhancing the carrying capacity of culture systems | **1** | **1** |
| | | | | |
| **2** | **Climate Change impact** | | **20 Hrs** | |
| | 2.1 | Principles of Biofloc; Factors influencing biofloc formation, Microbial communities in bioflocs; | **4** | **2** |

| | | | | |
|---|---|---|---|---|
| | 2.2 | Carbon sources, C:N Ratio; Biofloc quantity and Quality; Biofloc as a feed ingredient; Nutrient recycling in a biofloc system | **4** | **2** |
| | 2.3 | Stocking of finfish and shellfish in Biofloc medium,<br>Bioremediation in wastewater Aquaculture | **3** | **2** |
| | 2.4 | Recirculating Aquaculture System- Design and Components,<br>Design of mechanical and biological filters for water reuse systems | **5** | **3** |
| | 2.5 | Disposal of wastes and control of pollution to environment; biofiltration and Nitrifiers; suitable culture species for indoor culture systems, polyhouses | **4** | **3** |
| **3** | **Strategies for sustainable aquaculture and guiding principles for sustainable aquaculture** | | **20 Hrs** | |
| | 3.1 | Aquaponics Systems- Principle, Components and Design | **4** | **4** |
| | 3.2 | Water Quality and System Maintenance; Ratio of Fish and Plants, Resource Utilisation | **4** | **4** |
| | 3.3 | Nutrient recycling in Aquaponics systems and zero discharge of nutrients | **4** | **4** |
| | 3.4 | Running water systems; Flow through systems, Raceways (IPR) | **4** | **5** |
| | 3.5 | Integrated multitrophic Aquaculture Systems; Partitioned Aquaculture Systems (PAS) | **4** | **5** |
| **4** | **Practicals** | | **30 Hrs** | |
| | 4.1 | Study of the components of Biofloc, RAS and Aquaponics Systems | **10** | **2,3** |
| | 4.2 | Preparation and Maintenance of Aquaponics and Recirculating Aquaculture Systems | **10** | **4,5** |
| | 4.3 | Estimation of Ammonia, Nitrite, Nitrate , pH, Dissolved Oxygen and Carbondioxide in different Aquaculture Systems | **10** | **6** |

| 5 | Teacher Specific Content | |
|---|---|---|

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fishing Craft and Gear Technology** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG4DSEAQC201** | | | | | |
| **CourseLevel** | **200** | | | | | |
| **Course Summary** | Craft and gear technology is a term used in the context of fishing. Crafts or Boats provides a platform for fishing operations, carrying the crew and fishing gears. Nets or gear are the instruments used for catching fish. Various types of gears and crafts used in different parts depending upon the nature of water bodies and targeted species .The use of crafts and gears in fishing plays a very important role in enhancing the production . The syllabus covers topics such as traditional and modern fishing crafts of India, mechanization of fishing crafts, boat building materials, their maintenance, equipment, rules and regulations of fishing operation, and safety, different types of gears, their design, principle of operation, fish finding devices, Code of conduct of responsible fishing. | | | | | |
| **Semester** | **4** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | **3** | | **1** | | **75** |
| **Pre-requisites, if any** | Students should possess interest in fishery technology. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understand the basic principles fishing craft and gear operations. | **U** | **1,2** |

| | | | |
|---|---|---|---|
| 2 | Skills to identify different craft, boat building materials, gears, gear accessories, fishing gear materials | **S** | **1,2,3** |
| 3 | Develop interest in ecosystem conservation | **I** | **6,7,8** |
| 4 | Recall the maintenance procedures of craft and gear | **R** | **3,6,10,9** |
| 5 | Recognise the importance of fisheries legislation and responsible fishing | **U** | **6,7,8,10** |
| 6 | Understand the role of fish finding devices in fishing. | **U** | **1,4,5,6** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course Description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Fishing crafts** | | **12 Hours** | |
| | 1.1 | Classification and description of different type of fishing crafts in India (inland and marine) traditional, motorized and mechanized. Terminologies of craft.<br>**Activity:**Field visit to Harbour | **4** | **1,2** |
| | 1.2 | Fishing craft technology- Fishing craft materials- wood, steel, aluminum, Ferro-cement, FRP (GRP)- advantages and disadvantages. Craft care and maintenance - Marine corrosion, Fouling. | **4** | **1,4** |
| | 1.3 | General arrangements of different type of fishing boats -Trawlers, gill netters, purse seiners, long liners, trollers, deep sea vessels. | **4** | **1,2** |
| **2** | **Fishing gear** | | **13Hours** | |
| | 2.1 | Classification of fishing gear (FAO and A. Von Brandt). Care and maintenance. | 2 | 1, 2 |
| | 2.2 | Operation and design - trawl, purse seine, gill net, line fishing and squid jigging. | 5 | 1, 2 |

| | | | | |
|---|---|---|---|---|
| | 2.3 | Important fishing gear accessories- floats, sinkers, otter board, hook, swivel, shackle, ropes. | 2 | 2, 4 |
| | 2.4 | Fishing gear materials- natural, synthetic materials, properties and preservation, yarn numbering systems, direction of netting, type of knots, meshes, fly meshing. Mounting and webbing different methods, hanging co-efficient.<br><br>Activity:Visit to Matsysfed net making factory. | 4 | 2, 4 |
| **3** | **FAD's, Fish finding devices, Conservation, Responsible Fisheries and Fisheries Legislation** | | **20 hours** | |
| | 3.1 | Fish aggregating devices and artificial reefs; Impact of artificial reefs on fish stock improvement; | 4 | 6,3 |
| | 3.2 | Turtle Exclusion Devices (TED) - By-catch Reduction Devices (BRD). | 3 | 6,3,2 |
| | 3.3 | Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment, remote sensing. Activity: Visit to CIFT/CIFNET | 3 | 6,2 |
| | 3.4 | Concept of Responsible Fisheries; Monsoon trawl ban, closed season, mesh size regulations, juvenile fishing. | 3 | 3,5 |
| | 3.5 | Exclusive Economic Zone (EEZ), Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM). MSY, MEY, Over fishing, Recruitment over fishing, Aqua-ranching. | 3 | 3,5 |
| | 3.6 | Indian fisheries Act.1976. Coast Guard Act.1978, Maritime zones of India Act.1981. | 4 | 3,5 |
| **4** | **Practical** | | **30 Hours** | |
| | 4.1 | Identification of fishing crafts | 4 | 2 |
| | 4.2 | Identification of fishing gears, fishing accessories, (floats/sinkers/hook) | 10 | 2 |
| | 4.3 | Types of knots | 4 | 2,1 |
| | 4.4 | Identification of material used for gears -synthetic and natural fibers, twines, ropes, iron wares | 4 | 2,1 |
| | 4.5 | Study of Different Types of FAD's | 4 | 2,1 |

| | | | | |
|---|---|---|---|---|
| | 4.6 | Study of Fish Finding devices (GPS navigator, Sonar, Net Sonde, Gear Monitoring Equipment and Remote Sensing) | 4 | 1,2 |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Physiology and Internal Organisation of Finfishes and Shellfishes** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG4DSEAQC202** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | This course deals with the knowledge on how well an aquatic organism gets adapted in the aquatic ecosystem maintaining good health. Structure and functioning of different body systems such as digestive system, circulatory system, respiratory system, reproductive system and excretory system of finfishes and shell fishes are detailed. The food and feeding habits of fin fishes and shellfishesare incorporated.The study of age and growth in fish is a prerequisite to generate the inform atio on recruitment, longevity, mortality and fluctuations in fishery caused by various year classes, all of which can contribute towards planning for a rational exploitation of the fish stocks. The topics included in this paper also supports management of successful aquaculture practices. | | | | | |
| **Semester** | 4 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge on tissues, various organs and organ systems of animals | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Explain the digestive system and process of digestion in fin fishes and shell fishes. | U | 1,2,10 |
| 2 | Summarize the circulatory and respiratory systems of fin fishes and shell fishes | U | 1,3 |
| 3 | Utilize the knowledge on excretory, reproductive and nervous system of finfishes and shellfishes | A | 10 |

| | | | |
|---|---|---|---|
| 4 | Compare the food and feeding habits of fin fishesand shell fishes | U | 1,2 |
| 5 | Estimate the age and growth of fishes by various methods | C | 3 |
| 6 | Examine and Analyzevarious organs and organ systems of finfishes and shellfishes | An | 1,2,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | **Digestive system of fin fishes and shell fishes 15 Hrs.<br>Circulatory and respiratory system of finfish and shellfishes** | | | |
| 1 | 1.1 | Structure of digestive system of finfish<br>Physiology of digestion,<br>Associated digestive gland and their functions<br>Absorption and assimilation of nutrients<br>Hormones in the regulation of digestion<br>Factors affecting the process of digestion<br>Digestive system and Physiology of digestion in shell fishes (shrimp, bivalve and cephalopod) | 5 | 1 |
| | 1.2 | Structure of heart, blood vascular system<br>Cardiovascular physiology of finfishes.<br>Cardiovascular physiology of shell fishes. | 4 | 1 |
| | 1.3 | Gills and process of respiration in finfishes<br>Accessory respiratory organsof finfishes. | 3 | 1 |
| | 1.4 | Swim bladder<br>Swimming activity, social behaviour and migration in fishes | 3 | 1 |
| | **Excretory, reproductive and nervous system 15 Hrs.<br>Food and feeding habits of finfishes and shell fishes** | | | |
| | 2.1 | Excretory organs in finfish, their physiological functions and mechanism of excretion.<br>Osmoregulation in finfishes. Endocrine control of osmoregulation.<br>Excretory organs and physiology of excretion in shell fishes (shrimp, bivalve and cephalopod). | 5 | 3 |

| | | | | |
|---|---|---|---|---|
| 2 | 2.2 | Structure and physiology of reproductive system of finfishes. . Structure and physiology of reproductive system of shrimp and crab | 3 | 3 |
| | 2.3 | Nervous and lateral line system, sense organs (eye, ear, olfactory organs) of finfishes. Nervous system and sense organs of shell fishes (shrimp and bivalve). | 4 | 3 |
| | 2.4 | Natural food of fishes. Feeding habits and types of feeding in fishes- Carnivorous, Herbivorous and Omnivorous, Predators, Grazers, Suckers, Strainers and parasites. Feeding habits and method of feeding in shell fishes (Shrimp, bivalve, cephalopod). | 3 | 4 |
| 3 | **Age and growth studies of fish 15 Hours** | | | |
| 3 | 3.1 | Growth of finfishes- Absolute and relative growth, isometric growth and allometric growth. The cube law. | 3 | 5 |
| | 3.2 | Methods for determination of growth checks. Length frequency analysis. Analysis of growth using hard parts like scales, otoloiths and vertebrae. | 3 | 5 |
| | 3.3 | Estimation of growth by direct methods. Marking and tagging of fish for growth studies. | 3 | 5 |
| | 3.4 | Methods of studying reproduction Maturity Stages, Gonadosomatic Index, Ova Diameter Frequency studies. | 3 | 5 |
| | 3.5 | Determination of size at first maturity and spawning season, Fecundity and its determination. | 3 | 5 |
| 4 | **PRACTICAL 30 Hours** | | | |
| | 1 | Dissect and study the digestive system of fin fishes | 4 | 6 |
| | 2 | Structure of gills of finfishes (Herbivore, omnivore, carnivore) | 4 | 6 |
| | 3 | Gut content analysis of finfishes | 4 | 6 |
| | 4 | Nervous system of prawn | 4 | 6 |
| | 5 | Study of gill structure of crustacean | 2 | 6 |

| | | | | |
|---|---|---|---|---|
| | 6 | Study of gill structure of bivalve | 2 | 6 |
| | 7 | Dissect and understand the reproductive organs of finfishes | 4 | 6 |
| | 9 | Familiarize various types of tags used in age and growth studies | 2 | 6 |
| | 10 | Analysis of length frequency data | 4 | 6 |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |



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| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Seed Production and Hatchery Management of Shellfishes** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG4DSEAQC203** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | The course provides an in- depth knowledge on the seed production and hatchery management of various shellfish species through theoretical and practical components. The course is designed to cover topics such as brood stock selection, conditioning, seed production, larval rearing, hatchery management. | | | | | |
| **Semester** | 4 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess knowledge on the general biology of aquatic organisms. | | | | | |



## COURSE OUTCOMES (CO)



| CO No | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Summarize the current status of seed production techniques of shellfish species | U | 1,2 |
| 2 | Plan the broodstock selection and conditioning of shellfish for optimal seed production. | A | 1,2 |
| 3 | Develop skills in induced maturation, seed production and larval rearing. | A | 1,2,10 |
| 4 | Construct and develop techniques for live feed culture unit | C, A | 3,9,10 |

| | | | |
|---|---|---|---|
| 5 | Examine the water quality aspects of hatchery. | An | 1,2 |
| 6 | Develop fundamental skills in site selection and design of hatcheries. | A, C, S | 1,2,3 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

## COURSE CONTENT

### Content for Classroom transaction (Units)

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to seed collection and reproductive biology of shellfish 15 Hours** | | | |
| **1** | 1.1 | Current status of seed production of shellfish. | 1 | 1 |
| | 1.2 | Seed resources of various shellfishes. Site selection of seed resources, Collection methods and identification of different shellfish seed. | 3 | 1 |
| | 1.3 | Constraints and prospects in collection of seed. | 1 | 1 |
| | 1.4 | Reproductive biology of crustaceans (prawns, shrimps, crabs, lobsters) and molluscs (mussels,oysters,scallops, clams and cockles). | 2 | 2 |
| | 1.5 | Reproductive hormones in crustaceans and molluscs. | 1 | 2 |
| | 1.6 | Mechanism of reproduction in prawns,shrimps, crabs, lobsters,mussels,oysters,scallops, clams and cockles. | 3 | 2 |
| | 1.7 | Sexual maturity, breeding seasons of commercially important shellfish species. | 1 | 2 |
| | 1.8 | Factors affectingmaturationandspawning. | 1 | 2 |
| | 1.9 | Life cycle of important shellfish (*Penaeus monodon*, *Macrobrachiumrosenbergii*, *Scylla serrata*, lobster, edible oyster, pearl oyster, fresh water mussel). | 2 | 2 |
| | **BroodstockManagement and seed production 10 Hours** | | | |

| | | | | |
|---|---|---|---|---|
| **2** | 2.1 | Availability of broodstock. Selection criteria for broodstock (prawns,s hrimps, crabs, lobsters, mussels, oysters, scallops, clams and cockles). | 2 | 3 |
| | 2.2 | Nutritional requirements of broodstock. | 2 | 3 |
| | 2.3 | Transport, captive rearing and maturation of broodstock. | 2 | 3 |
| | 2.4 | Induced maturation and seed production of commercially important crustaceans (prawns, shrimps, crabs, lobsters, mussels,edibleoysters, pearl oysters, scallops,clams and cockles). | 4 | 3 |
| | **HatcheryTechnologyandManagement** | | **20 Hours** | |
| **3** | 3.1 | Site selection and facilities required for a shellfish hatchery (prawn, shrimp, oyster and mussels) | 3 | 4,5,6 |
| | 3.2 | Culture and use of different live feeds in shellfish hatcheries. | 3 | 4,5,6 |
| | 3.3. | Larval diseases and their management. | 2 | 4,5,6 |
| | 3.4. | Water quality (salinity, pH, dissolved oxygen, ammonia, nitrite, nitrate) and feed management. | 2 | 4,5,6 |
| | 3.5. | Different chemicals and drugs used for water quality and health management in hatcheries. | 2 | 4,5,6 |
| | 3.6. | Hatchery standards and biosecurity; sanitary and phyto sanitary (SPS) measures; better management practices(BMPs). | 3 | 4,5,6 |
| | 3.7. | Quality assessment of seeds. Packagingandtransportof seed. | 3 | 4,5,6 |
| | 3.8. | Economics of seed production. | 2 | 4,5,6 |
| **4** | **Practical** | | **30 Hours** | |
| | 4.1 | Identification of brood stock of important crustaceans (prawns, shrimps) and molluscs (mussels) . | 5 | 2 |
| | 4.2 | Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachiumrosenbergii*. | 4 | 2 |
| | 4.3 | Identification of larval stages of crustacean ns (prawns, shrimps) and molluscs (mussels). | 3 | 3 |
| | 4.4 | Demonstration of eyestalk ablation in *Penaeus monodon*. | 4 | 3 |

| | | | | |
|---|---|---|---|---|
| | 4.5 | Familiarisation of collection and packing techniques of shrimp/prawn seeds. | 5 | 6 |
| | 4.6 | Water quality analysis (salinity, pH, dissolved oxygen, ammonia, nitrite, nitrate) in hatcheries | 4 | 5 |
| | 4.7 | Demonstration of setting up of a live feed unit | 5 | 4 |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |



**REFERENCES**


1. Central Marine Fisheries Research Institute (CMFRI), Kochi. (1988). *National Seminar on Shellfish Resources and Farming Session I. Technical Report*. Central Marine Fisheries Research Institute, Kochi.
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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | | | | | | |
| **Course Name** | **Aquafarm Management** | | | | | |
| **Type of Course** | **SEC** | | | | | |
| **Course Code** | **MG4SECAQC200** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | Provides a comprehensive understanding of the principles and practices involved in the management of aquafarms, such as site selection, facility design, water quality management, stocking, and sustainable practices. | | | | | |
| **Semester** | 4 | Credits | | | 3 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | | | 45 |
| **Pre -requisites, if any** | Basic knowledge regarding fishes and fish rearing is desirable. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Summarize the different systems of aquaculture including recent techniques in aquaculture systems. | U | 1 |
| 2 | Understand the importance of aquaculture and criteria for the site selection of an aquafarm and selection species. Design and planning an aquafarm or hatchery | U, A, S | 1,2 |
| 3 | Demonstrate the pre-stocking pond preparation steps such as drying, ploughing, liming, and manuring and fertilization and proper procedures for grow out | A, S | 1,2 |
| 4 | Develop sufficient professional knowledge in fish farm to start own enterprise, outline the major diseases associated with farming practices and develop knowledge on disease management tools | A, S | 5,6,10 |
| 5 | Illustrate feed formulation techniques for the manufacture of nutritionally balanced feed | A, C, S | 1,2 |
| 6 | Mastery on hatchery operation and harvesting methods, familiarity with equipment operation | A, S | 1 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to Aquafarm Management & Site Selection** | **5 Hours** | | |
| 1 | 1.1 | Overview of aquaculture and its importance.<br>Historical perspective and global trends.<br>Sustainable aquaculture practices. | 2 | 1 |
| | 1.2 | Criteria for site selection<br>Types of aquaculture facilities (ponds, raceways, tanks)<br>Facility design considerations and planning. | 3 | 2 |
| | **Pre-stocking Management and Aquatic Species Selection** | **13 Hours** | | |
| 2 | 2.1 | Preparation of pond<br>Dike construction<br>Eradication of undesirable aquatic weeds ,Eradication of weed fishes,<br>Liming of pond,<br>Basal manuring and fertilization<br>Eradication of aquatic insects<br>Bio fencing<br>Activity: Attend training in fish farm | 10 | 3, 4 |
| | 2.2 | Selection of fish and shellfish species<br>Criteria for the selection of species | 3 | 2 |
| | **Stocking , Post Stocking Management, Harvesting and Post-Harvest Handling** | **27 Hours** | | |
| 3 | 3.1 | Handling and transportation of aquatic species Stocking densities and ratios | .2 | |
| | 3.2 | Water Quality Management<br>Importance of water quality in aquaculture<br>Monitoring and controlling water parameters<br>Aeration and circulation systems<br><br>**Activity:** Field trips to aquafarms | 8 | 4 |
| | 3.3 | Types of aquafeeds<br>Feed formulation and nutritional requirements<br>Feeding strategies and schedules<br><br>**Activity:** Visit/training in fish feed mills | 5 | 5 |

| | | | | |
|---|---|---|---|---|
| | 3.4 | Common diseases in aquaculture<br>Prevention and treatment of diseases<br>Quarantine practices | 3 | 4 |
| | 3.5 | Harvesting techniques<br>Processing and storage of aquaculture products<br>Value addition and marketing<br><br>**Activity:** Visit farm at the time of harvesting | 9 | 6 |
| **Teacher specific activities** | | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks |

**REFERENCES**




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**SUGGESTED READINGS**

1. Rath, R. K. - *Freshwater Aquaculture*.
2. Sadhu, A. K., & Chakraborty, C. - *Biology, Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*.
3. Chakrabarti, N. M. - *Biology, Culture and Production of Indian Major Carps: A Review*.
4. Closs, G., et al. - *Freshwater Ecology: A Scientific Introduction*.

# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | | | | | | |
| **Course Name** | **Sustainable Aquaculture Practices** | | | | | |
| **Type of Course** | **VAC** | | | | | |
| **Course Code** | **MG4VACAQC200** | | | | | |
| **Course Level** | **200** | | | | | |
| **Course Summary** | The course emphasizes the need and methods for sustainable aquaculture. Sustainable aquaculture is the aquaculture practice which focuses on environmental, economic, and social sustainability to improve capacity building and utilize land effectively for the aquaculture sector. Aquaculture encompasses a wide range of different aquatic farming practices with regard to species (including seaweeds, molluscs, crustaceans, fish and other aquatic species groups), environments and systems utilized, with very distinct resource use patterns involved, offering a wide range of options for diversification of avenues for enhanced food production and income generation in many rural and peri-urban areas.The student gains ideas on the 4 Pathways for sustainable aquaculture- Responsible production; Improving livelihoods; Healthy Consumption and an enabling environment. | | | | | | |
| **Semester** | **4** | Credits | | | **3** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | | | 45 |
| **Pre- requisites, if any** | A preliminary and basic idea on natural resources and sustainable practices for utilizing natural resources is desirable. | | | | | |



## COURSSE OUTCOMES

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Creating knowledge on reducing health issues through sustainable methods. | **U** | **1,2** |

| | | | |
|---|---|---|---|
| 2 | Developing skill to assess issues and thereby maintain sustainability of ecosystems through responsible production. | **S** | **1,2** |
| 3 | Utilize aquaculture practices which focuses on environmental, economic and social sustainability to improve capacity building and utilize land effectively for the aquaculture sector. | **An** | **1,2** |
| 4 | Formulate methods for enhancing the economic viability of aquaculture practices. | **C** | **1,2** |
| 5 | Evaluate the basic concepts about planning and aquaculture development. | **E** | **1,2** |
| 6 | Acquire indepth knowledge and field exposure on sustainable aquaculture practices. | **A, S** | **2,10** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Sustainability Aquaculture : Present Scenario and Problems** | | **10 Hours** | |
| | 1.1 | Role of aquatic resources in food and nutrition; Aquatic resource and livelihood systems. | **3** | **1** |
| | 1.2 | Different culture systems-Extensive culture , intensive culture, semi – intensive culture; RAS & Integrated Multi Trophic Aquaculture systems, Biofloc fish farming | **5** | **1** |
| | 1.3 | Trends in global and Indian aquaculture and its constraints | **2** | **1** |
| **2** | **Environmental and Socioeconomic Issues, Strategies for sustainability** | | **20 Hours** | |
| | 2.1 | Impacts of climate change; global warming | **5** | **2,3** |

| | | | | |
|---|---|---|---|---|
| | | Environmental degradation and disease outbreaks; Microplastics in aquaculture; pollution; Eutrophication. | | |
| | 2.2 | Socioeconomic issues: Conflicts over water and land use; conflicts of interest between aqua farmers and fishermen; resistance from local public; anti-dumping duties; waste water management in aquaculture. | **4** | **2,3** |
| | 2.3 | Sustainability concept; food security; biosecurity; organic farming; integrated farming; responsible aquaculture; rotational aquaculture; bioremediation; role of biotechnology, traceability; Seed certification, Sustainable use of antibiotics. | **4** | **2,3** |
| | 2.4 | Coastal Aquaculture Guidelines Source Book, FAO Code of Conduct for Responsible Fisheries. | **4** | **2,3** |
| | 2.5 | Aquaculture Stewardship Council, Ecolabelling, Marine Stewardship council | **3** | **2,3** |
| **3** | **Economic viability, Field Visit and Activity** | | **15Hours** | |
| | 3.1 | Export vs. Domestic marketing, value addition. | **3** | **4,5** |
| | 3.2 | Application of renewable energy in aquaculture - solar energy, wind, and tidal energy. | **2** | **4,5** |
| | 3.3 | Field visit to organic aquaculture farms<br>OR<br>Survey on good aquaculture practices among aqua farmers | **5** | **6** |
| | 3.4 | Create awareness on sustainable aquaculture practices among the aquafarmers through seminars/talks<br>OR<br>Attend Seminar on Sustainable practices. | **5** | **6** |
| 4 | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)** |

| | |
|---|---|
| | • Theory – 25 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks |

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# SEMESTER 5

# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Seed production and hatchery management of Finfishes** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG5DSCAQC300** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | This course offers an insight into seed production and hatchery technology of major finfishes. Seed production is the production of fish seeds in controlled condition in a hatchery. It involves broodstock rearing, artificial breeding methods, larval rearing and live feed culture. The aim of seed production is to produce fish seeds with desirable characters such as fast growth, disease resistance and so on by artificial propagation methods. To develop a successful seed production, infrastructure facilities, equipments, and trained personnel are mandatory. | | | | | |
| **Semester** | 5 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess knowledge regarding the basic biology f fishes. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domain | PO No |
|---|---|---|---|
| 1 | Explain different types of seed production and breeding methods. | U | 1 |
| 2 | Formulatedifferent criteria for designing a hatchery and the selection of equipments. | C | 1,2 |

| | | | |
|---|---|---|---|
| 3 | Analyze different steps and procedures involved in the preparation and management of nursery and rearing systems of fish breeding. | An | 1 |
| 4 | Prepare the criteria for the selection of broodstock and broodstock management. | U | 1 |
| 5 | Develop an Insight of natural breeding of finfishes and sexual maturity of different types of food fishes. | A, S | 1 |
| 6 | Develop fundamental skills in setting up of a fish hatchery | A, S | 1,2 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Hatchery management and seed production** | | **15 Hours** | |
| 1 | 1.1 | Criteria for the selection and construction of a hatchery. General design of hatcheries. Larval rearing unit, live feed culture unit. Water quality monitoring and management. Hatchery protocols, Economics of seed production | 5 | 2,6 |
| | 1.2 | Equipments and infrastructure facilities - Mechanical and biological filters, Incubators,Structure of hatching hapa. Breeding in hatching hapa. Auxiliary facilities in a hatchery- pumping unit, Electrical generator room, laboratory. | 3 | 2 |
| | 1.3 | Current trends in seed production,Selection criteria for broodstock and brood stock management, sex determination, Quarantine and disease management in hatcheries. | 3 | 4 |
| | 1.4 | Fish seeds- Types of seeds, embryonic development, Seed collection methods, Transportation of fish seed. Quality assessment of seeds. Larval rearing stages. Methods of breeding-Induced breeding-Hypophysation, stripping, Injection with LHRH-a, Bundh breeding techniques. | 4 | 1 |
| | **Seed production and hatchery management of freshwater fishes and air breathing fishes** | | **15 Hours** | |

| | | | | |
|---|---|---|---|---|
| 2 | 2.1 | Seed production and larval rearing of Indian major carps and exotic carps. Production of common carp seeds by different methods- Dubisch method, Sundanese, Tjimindi, methods followed in China and India. | 4 | 3,5 |
| | 2.2 | Induced breeding methods of carps, types of carp hatcheries- glass jar hatchery, Chinese circular hatchery. | 3 | 1, 2 |
| | 2.3 | Types of air breathing fishes. Respiratory adaptations of air breathing fishes. Seed production and nursery rearing of air breathing fishes- *Anabas testudineus,* Murrels -snake head. | 4 | 3,5 |
| | 2.4 | Seed production and hatchery management ofairbreathing catfishes- *Clarias sps*, *Heteropneustes sp*,*Pangasius pangasius sp* | 4 | 3,5 |
| | **Seed production and hatchery management of brackish water and marine fishes** **15 Hours** | | | |
| 3 | 3.1 | Seed production and hatchery technology of brackishwater fishes –Tilapia, *Mugil cephalus, Chanoschanos, Etroplussuratensis, Lates calcarifer.* | 8 | 3,5 |
| | 3.2 | Seed production and hatchery technologyof marine fishes - Cobia, Grouper, silver pompano. | 7 | 3,5 |
| **PRACTICAL** **30 Hours** | | | | |
| 4 | 1 | Demonstrate induced breeding by hypophysation or stripping | 6 | 1 |
| | 2 | Culture of live feed for hatchery | 6 | 3,5 |
| | 3 | Estimation of water quality in a hatching unit | 6 | 6 |
| | 4 | Identification of fish larval stages | 6 | 1,3,5 |
| | 5 | Demonstrate packaging of fish seed and brood fishes for transportation | 6 | 2,6 |
| 5 | Teacher Specific Content | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

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# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Post harvest Technology and Quality Control** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG5DSCAQC301** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | Post-Harvest Technology and Quality Control is a specialized course that delves into the processes and techniques involved in handling, processing, and ensuring the quality of fish products after harvest. Overall, the course aims to equip students with the knowledge and skills needed to effectively manage the post-harvest phase of fish production, ensuring quality, safety, and sustainability in the fisheries industry. Practical applications, hands-on experiences, and exposure to industry practices may also be integral parts of the course. | | | | | |
| **Semester** | 5 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess knowledge regarding general characters of fish | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Gain knowledge of the various post- harvest processes, including harvesting methods, handling, storage, transportation and packaging. | U | 1,2 |

| | | | |
|---|---|---|---|
| 2 | Familiarize with different preservation techniques of aquatic products | S, A | 1 |
| 3 | Familiarize with different freezing technology and techniques used in seafood industry | U,K | 1 |
| 4 | Identify the importance of packaging in food processing industry | U | 1,2 |
| 5 | Understanding National and International quality standards | S, A | 2 |
| 6 | Comprehend the principles of quality control and assurance in the context of fishery products, emphasizing factors that affect product quality | A, U | 2 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Handling and pre-treatment 10 hours** | | | |
| 1 | 1.1 | Fresh and spoiled fish & shellfish- characteristics of fresh fish, post mortem changes after death of fish. Onboard handling of seafood. | 3 | 1 |
| | 1.2 | Pre-treatment of fish-washing, Grading/ count, gutting, filleting, beheading, peeling, deveining etc. Depuration in shell fishes | 3 | 1 |
| | 1.3 | Quality of water and ice in fish handling and processing. Different types of ice used in the seafood industry. Chlorination of water.<br>Refrigeration cycle- principle & working. | 4 | 1 |
| | | | | |
| | **Preservation Techniques 19hours** | | | |

| | | | | |
|---|---|---|---|---|
| 2 | 2.1 | Principles of smoking, drying and salting of fish, Traditional drying / curing methods. Spoilage of dried products<br><br>Different types of Smoking: Cold, hot smoking, electrostatic smoking. Spoilage of smoked products. | **4** | **2** |
| | 2.2 | Thermal processing (Cooking, Sous-vide, Canning).<br><br>Canning- Outline of canning operations, Selection & preparation fish, blancing, clinching, exhausting, can seaming & washing, proceeding/ sterilization.<br><br>Spoilage of canned products | **4** | **2** |
| | 2.3 | Freezing- slow & quick freezing, factors affecting freezing, freezing curve of fish, Types of freezers, IQF,<br><br>Freeze drying and its significance. AFD and its merits | **4** | **3** |
| | 2.4 | Thawing. Conductive thawing methods (in air, water, vaccum) & non conductive methods of thawing (electrical resistance, dielectric, microwave, hybrid). | **3** | **3** |
| | 2.5 | Irradiation of food products | **1** | **4** |
| | 2.6 | Types of freezers used in seafood industry. Chilled and frozen storage of fish and fishery products. | **3** | **4** |
| **3** | **Packaging and Quality Assurance 16Hours** | | | |
| | 3.1 | Packaging- functions, requirements for fishery products, Different types of packing materials. Modified atmosphere packaging, controlled packaging and aseptic packaging. Flexible packing, retort pouch processing of fish and fishery products.Significance of Retortable pouch processing | 4 | 4 |
| | 3.2 | Changes associated with freezing - Supercooling, crystallization, thaw drip, gaping of fillets, thaw rigor, recrystallization & dessication, discolouration, toughness. | 3 | 3 |
| | 3.3 | Quality control – basic concepts& problems, quality assurance. Sanitory and hygiene requirements. Sanitation procedures in seafood processing plants. Waste management in fish processing industries. Risk factors in | 4 | 5, 6 |

| | | | | |
|---|---|---|---|---|
| | | seafood biotoxins, seafood pathogens, endogenous parasites. | | |
| | 3.4 | Physical, chemical & biological hazards in seafood. Quality control programmes - pre-shipment inspection,HACCP – concept, process and CCPs | 3 | 5, 6 |
| | 3.5 | Export of fishery products from India – major countries, important products, export documents and procedures. Traceability.<br>Quality certifications- IPQC, MIPQC, BRCGS and ISO Series in seafood industry. Ecolabelling. | 2 | 5, 6 |
| **4** | **PRACTICAL** | | **30 Hours** | |
| | 1 | Evaluation of fish / fishery products for organoleptic, chemical and microbial quality. | 3 | 1 |
| | 2 | Sanitary standards in fish processing units. | 3 | 5, 6 |
| | 3 | Filleting of fish, treatments, glazing, packaging, freezing. | 3 | 1 |
| | 4 | Process flow of Prawns, Lobster, Squid, Cuttle Fish, Crab etc. in different styles | 3 | 1 |
| | 5 | Freezing: Studies on physical, chemical and sensory changes during freezing. Production of frozen fishery products- dressed fish, fillets, minced fish, surimi, Production of prawn products- whole prawns, HL, PUD, PD, Butterfly prawns. | 3 | 3 |
| | 6 | Chill storage studies: Chemical, physical and sensory analysis, determination of shelf life. Handling of fish, bivalves, prawns, mollusks, Depuration, treatment with chemicals, evaluation of freshness of fish. | 3 | 3 |
| | 7 | Canning: Canning process of table fishes, Bivalves, Crustaceans in different containers, Canned culinary preparations, Examination of canned fishery products. Defects in canned fishery products. | 3 | 2 |
| | 8 | Preparation of dried, cured and fermented fish products, examination of salt, protein, moisture in dried / cured | 3 | 2 |

| | | | | |
|---|---|---|---|---|
| | | products, examination of spoilage of dried / cured fish products, marinades, pickles, sauce.. | | |
| | 9 | Field visit in a reputed seafood processing plant | 6 | 6 |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |



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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Inland and Marine capture fisheries** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG5DSEAQC300** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | The course introduced to study thebasics of marine and inland waters of the world and India, their fish fauna; global fish production trends; major fish producing countries and ecosystems; detailed account on pelagic, demersal, deepsea, riverine, lacustrine, reservoir, wetlands and estuarine fisheries, including crafts and gears;The students will get practical training on collection and identification of marine and inland fishery resources, demonstration of craft and gears and biometric studies through the visits to fish landing centres | | | | | |
| **Semester** | 5 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | | | | 60 |
| **Pre-requisites, if any** | Students should possess knowledge regarding marine and inland aquatic resources. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Students able to understand the different types of inland fisheries resourcesof the world and India. | U | 1,2 |
| 2 | Acquire knowledge regarding the present status of marine fisheries | A | 1,2 |

| | | | |
|---|---|---|---|
| 3 | Categorize and estimate the species wise landing pattern of pelagic fishery resources of India | An, C | 1,2 |
| 4 | Categorize and estimate the species wise landing pattern of demersal fishery resources of India | An,C | 1,2 |
| 5 | Formulate deep sea fishing policy of India | C,S | 1,2,6 |
| 6 | Evaluate the present status of crustacean and molluscan fishery resources of India | E | 1,2 |
| ***Remember (K), Understand (U), Apply (A), Analyze (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

## COURSE CONTENT

### Content for Classroom transaction (Units)

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Inland fishery resources** | | | **21 Hours** |
| 1 | 1.1 | Major inland waters of the world and India, their fish fauna; global inland fish production trends; major inland fish producing countries and ecosystems. | 3 | 1 |
| | 1.2 | Major river systems of India and Kerala and their fisheries. Current status, trend, and fishing methods of riverine fisheries | 2 | 1 |
| | 1.3 | Classification of reservoirs, present productivity levels and fishery potentials. Problems and prospects of reservoir fisheries in India. Measures to increase their production and economic management of reservoirs | 3 | 1 |
| | 1.4 | Estuarine fisheries resources of India, Fisheries of major estuarine systems in India and Kerala.Fishing methods, recent statistics of catches, problems encountered in fisheries development of major estuaries<br>*Activity: Collection and identification of fishes from rivers, reservoirs, lakes, estuaries and wetlands* | 6 | 1 |
| | 1.5 | Lacustrine fisheries: Fish fauna of natural lakes. Management and conservation of fisheries of lakes | 2 | **1** |
| | 1.6 | Flood-plain capture fishery- present status of their exploitation and future prospects. Bheel fisheries resources of India: Open and closed bheels<br>*Activity: Classify the different types of crafts and gear used in inland fishing* | 5 | **1** |

| | | | | |
|---|---|---|---|---|
| | **Marine fishery resources 22 Hours** | | | |
| | 2.1 | Introduction to marine fisheries of the world;Major fishing zones of world and India. Global marine fish production trends. FAO status | 3 | 2 |
| 2 | 2.2 | Introduction to marine fisheries of India. Pelagic, demersal and deep-sea fishery resources | 2 | **2** |
| | 2.3 | Pelagic fisheries of India: sardines, mackerels, anchovies, white baits, tuna, seer fish,carangids, ribbonfish, shads and other clupeids, barracudas, Bombay duck, pomfrets, mullets<br>*Activity- Visit- Marine fish landing Centre,Collection and identification of commercially important marine fin fishes.* | 6 | 3 |
| | 2.4 | Features and trends in the production of pelagic fisheries. Conservation of pelagic fish stock | 2 | 3 |
| | 2.5 | Demersal fisheries of India: Elasmobranchs (sharks, rays and skates),perches, threadfinbreams, groupers, snappers, Bull's eye, flat fishes, sciaenids, eels. | 5 | 4 |
| | 2.6 | Features and trends in production of demersal fisheries. Conservation of demersal fish stock<br>*Activity: Classify the different types of crafts and gear used in marine fishing* | 4 | 4 |
| 3 | **Deep sea fishery resources** | | | **4 Hours** |
| | 3.1 | History of deep-sea fishing. Oceanic and deep-sea fisheries of India. Potential resources. | 2 | 5 |
| | 3.2 | Deep sea fishing policy of India | 2 | 6 |
| | **Crustacean and molluscan fishery resources** | | | **13 Hours** |
| 4 | 4.1 | Crustacean fishery of India: Penaeid and non-penaeid shrimp fisheries. | 3 | 6 |
| | 4.2 | Lobster fishery, Crab fishery | 2 | 6 |
| | 4.3 | Molluscan fishery of India: Mussel fishery, Oyster fishery, Clam fishery. Cephalopod fishery,Gastropod fishery<br>*Activity: Collection and identification of commerciallyimportant shellfishes* | 8 | 6 |
| 5 | | **Teacher Specific Content** | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fish Genetics and Biotechnology** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG5DSEAQC301** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | The course imparts knowledge on the principles and techniques employed in the field of fish genetics and biotechnology. The course is designed to cover aspects on selective breeding, hybridization, sex manipulation, chromosome manipulation and different molecular biological techniques used in aquaculture. Genetic modification and biotechnology embrace tremendous potential to improve the health of fish population. | | | | | |
| **Semester** | 5 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | | - | | 60 |
| **Pre-requisites, if any** | Students should possess knowledge regarding general introductory biology and basic principles of Genetics. | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Explain the fundamental tools in genetics and biotechnology. | U | 1, 2 |

| | | | |
|---|---|---|---|
| | | | |
| 2 | Categorize the different hybridization methods and the methods of sex determination in fish. | An | 1, 2 |
| 3 | Explain the various sex manipulation techniques to suit the needs of aquaculture. | U | 1, 2 |
| 4 | Summarize the various chromosome manipulation techniques adopted in aquaculture | U | 1, 2 |
| 5 | Develop fundamental skills to demonstrate PCR amplification and recombinant DNA technology in fisheries and aquaculture . | A, S | 1, 2, 10 |
| 6 | Examine the applicability of molecular biology in marine biology and aquaculture. | An | 1, 2, 10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |
| | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to fish genetics and biotechnology** | | **15 Hours** | |
| **1** | 1.1 | Introduction to genetics. Gene, chromosome as basis of inheritance. Phenotype and genotype. Test cross and back cross. Mendelism.<br>Activity: Problems on Mendelian inheritance | 6 | 1 |
| | 1.2 | Population genetics - Hardy-Weinberg law and its significance. Factors affecting Hardy-Weinberg's law.<br>Activity: Problems on Hardy-Weinberg law | 5 | 1 |

| | | | | |
|---|---|---|---|---|
| | 1.3 | Practical applications of genetics in aquaculture. Scope and the present status of marine biotechnology. | 2 | 1 |
| | 1.4 | Activity: Preparation of models of DNA and Chromosomes | 2 | 1 |
| | **Selection, hybridization and domestication** | | **8 Hours** | |
| **2** | 2.1 | Principles of breeding- methods and selection. Genetic selection, mass selection, genotypic selection, family and sib selection, progeny testing and combined selection. | 4 | 2 |
| | 2.2 | Hybridisation -selective hybridisation, intra-specific and inter-specific hybridisation, heterosis. Inbreeding and its consequences. | 3 | 2 |
| | 2.3 | Domestication and strain evaluation. | 1 | 2 |
| **3** | **Genetics of fish sex determination and chromosome manipulation** | | **10 Hours** | |
| | 3.1 | Genetics of sex determination in fish. Gonochorism, Hermaphroditism, Protandry, Protogyni, Sexual dimorphism, Environmental influence of sex Determination. | 4 | 2 |
| | 3.2 | Androgenesis, Gynogenesis, Polyploidy | 3 | 4 |
| | 3.3 | Monosex production, super male fish production techniques, sex reversal– mechanisms and applications. | 3 | 3 |
| | **Biotechnological applications in Aquaculture and marine sciences** | | **27 Hrs** | |
| **4** | 4.1 | Introduction to molecular biological techniques applicable inaquaculture and marine sciences. | 1 | 6 |
| | 4.2 | Recombinant DNA technology - cloning, vectors, transformation. Use of PCR for aquatic health management. GMOs (Transgenics) in aquaculture; genes of interest- Anti- Freeze Protein, disease resistance genes, growth hormone gene, gene transfer mechanisms in production of transgenic fish.<br>Activity: Demonstration of PCR amplification | 10 | 5 |
| | 4.3 | Synthetic hormones for induced breeding | 2 | 6 |

| | | | | |
|---|---|---|---|---|
| | 4.4 | Cryopreservation of fish gametes. Probiotics, prebiotics, bioremediators, immunostimulants, immunomodulators. Vaccines–bio film vaccines, DNA vaccines, recombinant vaccine. Activity: Familiarisation of equipments used in cryopreservation | 8 | 5 |
| | 4.5 | Marine bioresources–bioactive compounds from the sea, marine natural products and metabolites from different marine organisms. Marine toxins. | 6 | 6 |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |



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| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Value added Fishery Products and Byproducts** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG5DSEAQC302** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | This course explores the various byproducts generated in the fishing industry and focuses on value addition through processing techniques, creating sustainable practices, and developing innovative products from fishery byproducts. | | | | | |
| Semester | 5 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | - | - | - | 60 |
| **Pre-requisites, if any** | Students should have an overview of the different commercially available fishes used in Fish processing Industry | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains * | PO No |
|---|---|---|---|
| 1 | Identify fishery byproducts and understand market trends, present status and distribution of value-added seafood products and consumer preferences. | U, An | 1,4 |
| 2 | Explain the technical preparation of fish mince based products with special emphasis on surimi production. | E, An | 1,2,6 |
| 3 | Explain the preparation, packaging and storage as well as quality evaluation of coated fishery products. | E,U | 1,2,5 |

| | | | |
|---|---|---|---|
| 4 | Summarize the preparation of a number of other value added products such as pickles, wafers, chutney powders, steaks, cutlets etc, from fish or shrimp. | U,I | 1,6 |
| 5 | Apply principles of sensory evaluation to assess product quality and study the characteristics of fish, its nutritional quality and relation to spoilage. | A,S | 1,8,9 |
| 6 | Develop to prepare by-products like chitin, chitosan, fish silage, fish meal, fish oil etc. for commercial gain. | C,A | 4,5,10 |
| | ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E),Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to Value Addition in Seafoods, Fish Mince Based Products** | | **20 Hrs** | |
| 1 | 1.1 | Definition of Value Addition<br>Overview of Value added products; Present market trends and consumer preferences, Scope of value addition.<br>**Activity:**<br>**1.** Sensory Evaluation of Fish | 4 | 1 |
| | 1.2 | Status of value addition in Indian seafood sector, Types of value added products.<br>Significance and advantages of value addition in the seafood industry. | 4 | 1 |
| | 1.3 | **Fish Mince Based Products**<br>Definition of Fish mince and Surimi. Raw materials used for surimi.<br>Production of fish mince and Surimi including Flow chart | 4 | 2 |
| | 1.4 | Fibreized and other products from Fish Mince. | 2 | 2 |
| | 1.5 | Equipments used for surimi preparation.<br>Different methods in assessing quality of surimi.<br>Define cryoprotectants. Role of different cryoprotectants in surimi production. | 6 | 2 |
| | **Coated fishery products and other Value Added Products** | | **15hrs** | |

| | | | | |
|---|---|---|---|---|
| 2 | 2.1 | Definition of coated fishery products and its preparation. Battered and breaded fishery products and its applications. | 5 | 3 |
| | 2.2 | Packaging and storage of coated products. Quality evaluation | 5 | 3 |
| | 2.3 | Preparation of Value Added Products viz. fish / prawn pickle, fish wafers, prawn chutney powder, fish soup powder, fish protein hydrolysate, fish stacks, fillets, marinated products. **Activity:** **1.** Fish filleting and preparation of fish steak. 2.Fish/Prawn pickling 3.Preparation of fish wafers, fish cutlet and fish fingers. | 5 | 4 |
| | **Fishery By-products** | | **17 hrs** | |
| 3 | 3.1 | Production of chitin, chitosan and glucosamine hydrochloride from shrimp shell waste. Extraction of collagen from fish processing wastes, properties and application. Definition of fish silage, Types of fish silages and their preparation. Uses of silage. **Activity:** **1.** Preparation of silages from low cost Fishes and Fishery wastes 2. Study and preparation of flowcharts for the production of Chitin and Chitosan from fishery waste | 6 | 6 |
| | 3.2 | Isinglass, shark fin rays, gelatin from fish waste. Ambergris, beche-de-mer, squalene, fish meal and oil- Extraction and Preparation in brief **Activity** Identification and Study of preparation of Fishery byproducts like Isinglass, shark fin rays, gelatin from fish waste. Ambergris, beche-de-mer, squalene, fish meal and oil. Or Industrial visit to units manufacturing Fishery byproducts/Value added products | 6 | 6 |
| | 3.3 | Seaweed products - agar, alginic acid and carrageenan. **Activity:** Study of production of seaweed products- agar, alginic acid and carrageenan. | 5 | 6 |
| 4 | | **Quality Control and Safety in Value Added Products** | 8 Hrs | |
| | 4.1 | Fish as raw material for processing: Factors affecting quality of fresh fish: intrinsic and extrinsic factors. | 4 | 5 |

| | | | | |
|---|---|---|---|---|
| | 4.2 | Spoilage in thermal processed products – Quality evaluation of thermal processed products<br><br>Curing and drying of fish – Spoilage in dry fish products | 4 | 5 |
| 5 | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Aquaculture Ecosystem Management and Climate Change** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG5DSEAQC303** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | The course provides an in-depth exploration of the impacts of climate change on marine and freshwater ecosystems, emphasizing the challenges and opportunities it presents for sustainable aquaculture practices. Through a blend of theoretical knowledge and practical application, students will learn to assess vulnerabilities, devise adaptation strategies, and contribute to the resilience of aquatic resources in the face of global climate change. | | | | | |
| **Semester** | **5** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | - | - | - | 60 |
| **Pre-requisites, if any** | Students should possess a preliminary knowledge on climate change issues and common Aquaculture Practices. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Understand the basic science of climate change, its global effects, and the importance of communication and public awareness. | **U** | **1,2** |
| 2 | Analyze the impact of climate change on marine and freshwater ecosystems, including ocean acidification and deoxygenation. | **An** | **1,9** |

| | | | |
|---|---|---|---|
| 3 | Evaluate the vulnerability of aquaculture to climate change and identify sustainable adaptation and mitigation practices. | **E** | **1,2,10** |
| 4 | Apply traditional knowledge and technological innovations to enhance climate resilience in aquaculture practices. | **Ap** | **1,9** |
| 5 | Evaluate policies and governance frameworks to enhance climate resilience in aquaculture at both international and national levels | **E** | **2,3** |
| 6 | Apply field-based learning to observe and assess the application of climate-smart aquaculture practices in real-world settings | **Ap** | **1,3** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Fundamentals of climate change and Effects on Aquatic Ecosystems** | | **12 Hrs** | |
| | 1.1 | Introduction to Climate Change: Overview, causes, and global effects. | **3** | **1** |
| | 1.2 | Climate Change Science: Understanding greenhouse gases | **2** | **1** |
| | 1.3 | Impact of Climate Change on Global Weather Patterns: Changes in temperature, precipitation, and extreme weather events. | **4** | **1** |
| | 1.4 | Climate Change Communication and Public Awareness | **3** | **1** |
| 2 | **Climate Change and Aquatic Ecosystems 16 Hrs** | | | |
| | 2.1 | Effects on Marine Ecosystems: Ocean acidification, sea temperature rise, and impacts on coral reefs. | **4** | **22** |
| | 2.2 | Effects on Freshwater Ecosystems: Changes in river flows, lake temperatures, and ice cover | **4** | **2** |
| | 2.3 | Biodiversity Loss and Species Migration: Consequences for aquatic food webs and species distribution | **4** | **2** |
| | 2.4 | Ocean Deoxygenation and Its Effects | **4** | **2** |

| | | | | |
|---|---|---|---|---|
| 3 | **Climate Change Impacts on Aquaculture and Mitigation practices 20 Hrs** | | | |
| | 3.1 | Vulnerability of Aquaculture to Climate Change: Risk assessment and management.<br>Adaptation Strategies for Aquaculture: Breeding, feed management, and disease control | **4** | **3** |
| | 3.2 | Climate-Induced Changes in Aquatic Pathogens and Disease Dynamics<br>Reducing carbon footprint in aquaculture operations. | **4** | **3** |
| | 3.3 | Integrated Multi-Trophic Aquaculture (IMTA), recirculating aquaculture systems (RAS).<br>Ecosystem-based Aquaculture Management: Conservation and restoration of aquatic habitats | **4** | **3** |
| | 3.4 | Carbon Sequestration in Aquatic Environments: Blue carbon ecosystems<br>Water Use Efficiency and Management: Techniques for reducing water footprint. | **4** | **3,4** |
| | 3.5 | Policy and Governance for Climate-Resilient Aquaculture: International agreements and national strategies | **4** | **5** |
| **4** | **Climate Resilience in Indian Aquaculture 12 Hrs** | | | |
| | 4.1 | Impact of Monsoon Variability on Aquaculture: | **2** | **6** |
| | 4.2 | Mangrove Ecosystems as Natural Defenders | **2** | 4 |
| | 4.3 | Traditional Knowledge and Adaptation Strategies | **2** | 4 |
| | 4.4 | Technological Innovations for Climate-Smart Aquaculture | **2** | 6 |
| | 4.5 | Policy Framework for Climate-Adaptive Aquaculture in India<br>**Activities:**<br>**Visit or make models of IMTA and RAS**<br>**Field Trips** | **4** | 5 |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Cold Water Aquaculture, Recreational Fisheries and Integrated Multitrophic Aquaculture** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG5DSEAQC304** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | Coldwater Fish Culture explore all husbandry activities associated with cold water fish culture. The curriculum follows the entire life cycle of a fish lot in a hatchery setting. Participants will explore the various techniques and calculations most often used in the aquaculture industry, including egg enumeration and handling, egg incubation, hatching methods, methods in brood stock management, and fish stocking. Students able to understand different sport fishes and importance as sport fisheries. Students gain knowledge on advanced integration practices along with aquaculture forenhancing aquaculture production | | | | | |
| **Semester** | 5 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practicals | Others | |
| | | 4 | - | - | | 60 |
| **Pre-requisites, if any** | Students should possess basic knowledge regarding aquaculture and integration in aquaculture processes. | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domain | PO No |
|---|---|---|---|
| 1 | Understand the global status of cold-water fisheries, with an emphasis on India, assessing challenges and opportunities. | U | 1,2 |
| 2 | Identify and differentiate major cold-water fish species in India, highlighting their ecological and economic significance. | U, An | 1,2 |

| | | | |
|---|---|---|---|
| 3 | Demonstrate an in-depth understanding of the biology, breeding, and culture of trouts and Mahseer, including their environmental requirements. | C, U | 1,2 |
| 4 | Design and evaluate the construction and management of cold-water fish farms, considering species-specific needs and environmental impacts. | C, E | 1,2 |
| 5 | Evaluate sports fishes' life history, selecting appropriate equipment, and methods for sports fishing while considering conservation practices. | E | 1,2 |
| 6 | Design and construct a model integrated fish farm, aquaponics and IMTA considering environmental effects and conducting an economic analysis of different integrated culture systems. | C | 2,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction** | | | **14 Hours** |
| 1 | 1.1 | Introduction: Status of cold-water fisheries in world with special reference to India.Major cold water fish species in India<br>*Activity*: *Identification of cold water fish species; Primary and secondary sexual charactersin cold-water fishes* | 4 | 1,2 |
| | 1.2 | Threats to cold water fish diversity in India; habitat destruction, overexploitation, exotic fish introduction,and climate change | 3 | 1,2 |
| | 1.3 | Biology, and captive breeding of snow trout, exotic trout's, mahseer and common carps | 4 | 1,2,3 |
| | 1.4 | Specific environmental parameters pertaining to cold water fish culture and metabolic interaction, Feeds suitable for cold water aquaculture. | 3 | 1 |
| | **Culture of Coldwater fishes** | | | **18 Hours** |
| | 2.1 | Culture of major trout species (*Oncorhynchus mykiss, Salmo trutta fario, Schizothoraichthys esocinus, S. longipinnis, S. niger, Schizothoraxrichadsoni*i) from India | 4 | 3 |

| | | | | |
|---|---|---|---|---|
| 2 | 2.2 | Culture of Mahseer (*Tor putitora, Tor tor, Tor khudree,Neolissochilushexagonolepis*) and Common carp (*Cypinuscarpiocummuinis*, *Cyprinus carpiospecularis,Carrasiuscarrasius*) species from India.<br>*Activity: Identification of larval stages of trout and mahseer;Preparation of hatchery layout for cold-waterfishes* | 6 | 3 |
| | 2.3 | Construction and management of cold-water fish farms, Polyculture of exotic carp in mid-hill region based on three Chinese carps, post-harvest and harvest issues in trout with regards to cold water species<br>*Activity- Visit to cold water fish hatchery* | 5 | 3,4 |
| | 2.4 | Special factors forconsideration in cold water fish seed production and nursery rearing.Issues and Desired Interventions: Potential and Innovative Strategies for the Development of Coldwater Aquaculture in India- problems encountered in fisheries development of rivers supporting cold water fisheries | 3 | 4 |
| | **Recreational Fisheries** | | **10 Hours** | |
| 3 | 3.1 | Introduction,Development of Recreational Fisheries in India. Major sport fishes | 2 | 5 |
| | 3.2 | Equipment's for sports fishing, fishing methods, area suitable for sports fishing, etc<br>*Activity: Studies on different types of sports fishing equipment* | 4 | 5 |
| | 3.3 | Management and conservation of sports fisheries through aquaculture | 2 | 5 |
| | 3.4 | Sport fisheries and tourism, recreational aquaculture | 2 | 5 |
| 4 | **Multilevel Integrated Aquaculture Systems and Integrated Multitrophic Aquaculture System (IMTA) 18 hour** | | | |
| | 4.1 | Integrated fish farming: Global status, integration with agricultural (paddy), horticultural crops (vegetable and fruits) and livestock (cattle, poultry, ducks, pigs and other terrestrial animals)<br>*Activity- Construct a model integrated fish farm* | 4 | 6 |
| | 4.2 | Effective recycling of wastes, nutrient budgeting indifferent integrated farming systems. Production levels and economics | 2 | 6 |
| | 4.3 | Bioprocessed manures in integration: Vermicompost, farmyard manure compost, biogas slurry, etc. Advantages of biomanures, Control of microbial interactions,Fermentation of manures | 4 | 6 |

| | | | | |
|---|---|---|---|---|
| | | *Activity: Preparation of vermicompost; Analysis of nutrient value of different manures* | | |
| | 4.4 | IMTA Concepts:Integrated multitrophic aquaculture systems and design of an IMTA unit, Aqua tourism.<br>*Activity- Visit an IMTA unit* | 3 | 6 |
| | 4.5 | Aquaponics: concept, Principles, types and operation<br>*Activity: Different models of aquaponics;Nutrient analysis and management in aquaponics* | 2 | 6 |
| | 4.6 | Bio-resource flow in integrated aquaculture system: Discharge of nutrient wastes from integrated aquafarms | 1 | 6 |
| | 4.7 | Environmental effects, and potential for integrated multi-trophic aquaculture, An economic analysis of different integrated culture systems | 2 | 6 |
| 5 | | **Teachers Specific Content** | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

## REFERENCES


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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fabrication and Setting of Marine and Freshwater Aquarium** | | | | | |
| **Type of Course** | **SEC** | | | | | |
| **Course Code** | **MG5SECAQC300** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | Aquarium Keeping and Aquarium Fish Breeding is one of the most popular and enticing hobbies in the world today. It is in fact a multibillion dollar industry and needs trained expertise. India, with its rich resources of endemic and unique specimens is slated to become a major player in the field. The country needs trained personnel and expertise in order to utilize its rich potential of resources. The course is aimed at imparting skill in the preparation of varieties of aquaria using the latest materials and techniques available | | | | | |
| **Semester** | **5** | Credits | | | 3 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | | | 45 |
| **Pre-requisites, if any** | Students should possess knowledge regarding general characters of fishes . | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Illustrate the design and construction of home and public aquaria | U | PO1 |
| 2 | Illustrate the setting and maintenance of aquariums in addition to water quality management. | U | PO1 |
| 3 | Management of home as well as commercial aquariums. | AP | PO2 |

| | | | |
|---|---|---|---|
| 4 | Develops skills to handle different aquarium equipments | AP | PO1 |
| 5 | Manage and Maintain Aquascaping and Decorations in an Aquarium | AP | PO1 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to Aquaria** | | **10 Hrs** | |
| | 1.1 | Definition of aquarium, scope and history | **2** | **1** |
| | 1.2 | Fabrication of home aquarium<br>**Activity**: Construction of a Freshwater Aquarium | **3** | **1** |
| | 1.3 | Design and construction of public fresh water and marine aquaria. | **3** | **1** |
| | 1.4 | Types of materials used in aquarium fabrication- Suitability, Advantages and Disadvantages | **2** | **1** |
| **2** | **Aquarium Accessories** | | **10 Hrs** | |
| | 2.1 | Aeration of water and Types of Aerators | **2** | **2** |
| | 2.2 | Different kinds of Filters and Lighting | **2** | **2** |
| | 2.3 | Thermostat for aquaria | **2** | **2** |
| | 2.4 | Hand nets and other equipments | **2** | **2** |
| | 2.5 | Aquarium gravels, pebbles, hood and aquarium plants | **2** | **2** |
| **3** | **Aquarium Setting, Maintenance and Aquarium Trade** | | **25 Hrs** | |
| | 3.1 | Site selection for Aquaria | **2** | **2** |
| | 3.2 | Setting up of fresh water aquarium<br>**Activity:** Set up a Freshwater Home Aquarium | **3** | 2,5 |
| | 3.3 | Setting up of marine aquarium | **3** | 2 |
| | 3.4 | Aquascaping- Different styles and Types | **2** | 2 |
| | 3.5 | Water quality parameters, Cleaning of aquarium, Filtration of Aquarium water – different types of Filters and Filtration.<br>Activity | **5** | 2 |

| | | | | |
|---|---|---|---|---|
| | | 1. Measurement of water Quality parameters<br>2. Setting up of a Biofilter and Recirculating System. | | |
| | 3.6 | Nutritional requirements of aquarium fishes, Artificial and Live Feeds for Aquarium Fishes,<br>**Activity:** Hatching of Artemia cysts | **5** | 3 |
| | 3.7 | Present Status of aquarium trade in India and the World. | **5** | **4** |
| **4** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | **lecturing with ICT**<br>**Activities**<br>**Transactions** |
| **Assessment Types** | **MODE OF ASSESSMENT**<br>**A. Continuous Comprehensive Assessment (CCA)**<br>• Theory- 25 Marks |
| | **B. Semester End Evaluation (ESE)**<br>**Theory**<br>• Very Short Answer Questions (10 out of 12):10X 1=10<br>• Short Answer Questions (6 out of 9): 6x5=30<br>• Essay (1 out of 3):1 X 10= 10 Marks<br>• Total – 50 Marks |

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# SEMESTER 6

# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Coastal Aquaculture and Mariculture** | | | | | |
| **Type of Course** | **DSC A** | | | | | |
| **Course Code** | **MG6DSCAQC300** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | The importance of coastal aquaculture in the context of augmenting fish production, improving rural economy and productive utilisation of water resources is well-established. Mariculture is and will increasingly become an important producer of aquatic food in coastal areas, as well as a source of employment and income for many coastal communities. Well-planned and -managed mariculture can also contribute positively to coastal environmental integrity. Considering the fact that mariculture's future development will occur, in many areas, with increasing pressure on coastal resources caused by rising populations, and increasing competition for resources, this course aims to payconsiderable attention to improve the sustainable aquaculture production through environmentally sound technology and better management | | | | | |
| **Semester** | 6 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge of aquaculture | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Design coastal aquaculture systems (tanks, ponds, pens, cages, etc.) | C | 1,2 |
| 2 | Understand the commercially important cultivable brackish water and marine organisms and learn to apply the knowledge acquired in field | U, A | 1,2 |

| | | | |
|---|---|---|---|
| 3 | Design grow-out culture units of fin fishes (tanks, ponds, pens, cages, etc.) / provide consultancy services to the farmers. | C | 3,5,6 |
| 4 | Design grow-out culture units of shell fishes / provide consultancy services to the farmers. | C | 4,5,6,9 |
| 5 | Develop skill to manage aquafarm in effective and sustainable manner . | A, S | 4,5,8,9 |
| 6 | Develop interest in entrepreneurship and skill to utilize various aquaculture practices. | I, S | 7,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Site selection, Design and Construction of coastal aquaculture f And Selection of Candidate species** | | **15 Hours** | |
| 1 | 1.1 | An overview of sea farming and shore-based aquaculture - global and Indian perspective; scope, potential and emerging trends | 2 | 1 |
| | 1.2 | Principles of coastal aquaculture and mariculture. Sea Ranching | 2 | 1 |
| | 1.3 | Farming systems: Cage, Pen,Traditional- Pokkali, Basabadha; extensive, modified extensive, semi intensive and intensivesystems | 2 | 1 |
| | 1.4 | Site selection for marine and brackish water farms.Farm construction, Water treatment | 3 | 1 |
| | 1.5 | . Selection of candidate species for coastal aquaculture and its biology and early development<br><br>(sea bass, mullet, milkfish, grouper, cobia, snappers, pearlspot, tiger shrimp, white shrimp, mud crab, lobster, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, abalones, scallops, sea urchin and sea cucumbers). | 3 | 2 |
| | 1.6 | Economic and market values of important coastal aquaculture species (seabass, mullet, milkfish, grouper, cobia, snappers, pearlspot, tiger shrimp, white shrimp, mud crab, lobster, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, abalones, scallops, sea urchin and sea cucumbers) | 3 | 1,2,5 |
| 2 | **Culture of fin fishes and Shell fishes** | | **15 Hours** | |

| | | | | |
|---|---|---|---|---|
| | 2.1 | *Chanos chanos, Mugil cephalus, Etroplus suratensis, Trachinotus blochii, Lates calcarifer, Rachycentron canadum*, groupers. | 4 | 6. 3,5 |
| | 2.2 | 5. Different mariculture techniques and technological advancements | 4 | 3 |
| | 2.3 | Culture of Shrimp, Mud crab, lobsters, clams, mussels, oysters (pearl and edible), Pearl implantation. | 4 | 4 |
| | 2.4 | Culture of sea cucumbers, Seaweed, abalones, sea urchin, scallops. | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| **3** | **Farm Management** **15 Hours** | | | |
| 3 | 3.1 | Farm Management and monitoring of brackish water and marine fin fishes (*Chanoschanos, Mugil cephalus, Etroplussuratensis, Trachinotusblochii, Lates calcarifer, Rachycentron canadum*, groupers).<br><br>Farm Management and monitoring of brackish water and marine shell fishes Shrimp, Mud crab, lobsters, clams, mussels, oysters (pearl and edible), sea cucumbers, Seaweed, abalones, sea urchin, scallops | 5 | 5 |
| | 3.2 | Sampling, Feeding and Feed Management of *Chanoschanos, Mugil cephalus, Etroplussuratensis, Trachinotusblochii, Lates calcarifer, Rachycentron canadum*, groupers, Shrimp, Mud crab, lobsters, clams, mussels, oysters (pearl and edible), sea cucumbers, Seaweed, abalones, sea urchin, scallops. | 5 | 5 |
| | 3.3 | Harvesting methods*Chanoschanos, Mugil cephalus, Etroplussuratensis, Trachinotusblochii, Lates calcarifer, Rachycentron canadum*, groupers, Shrimp, Mud crab, lobsters, clams, mussels, oysters (pearl and edible), sea cucumbers, Seaweed, abalones, sea urchin, scallops | 5 | 5 |
| 4 | **PRACTICAL** **30 Hours** | | | |
| 4 | 1 | Collection and identification of seeds of commercially important fin fishes and shellfishes. | 6 | |
| | 2 | Estimation of seed survival, Biomass estimation. | 4 | |
| | 3 | Estimation of Water quality parameters of farm (pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate, primary productivity, alkalinity, hardness). | 10 | |
| | 4 | Familiarize material, apparatus and machinery for shore-based aquaculture and sea farming | 4 | |
| | 5 | Estimation of feed intake. Growth and health monitoring | 4 | |
| | 6 | Fouling organisms in cages and pens, rafts and rack. | 2 | |

| 5 | **Teacher Specific Content** |
|---|---|

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

**REFERENCES**


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2. Bensam, P., & Vasudeva, P. (1993). *Handbook on aquafarming: Seafishes oceanic cage culture manual*. MPEDA.
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# Mahatma Gandhi University

| | |
|---|---|
| **Programme** | **BSc (Hons) Aquaculture** |
| **Course Name** | **Fish Microbiology and quality Assurance of seafood** |
| **Type of Course** | **DSC A** |
| **Course Code** | **MG6DSCA QC301** |
| **Course Level** | **300** |
| **Course Summary** | The desirable nutritional qualities make fish and fishery products as an ideal source of animal protein requirements of fish-eating population. Several microorganisms responsible for spoilage and also human pathogens associated with foods affect the safety and quality of food meant for human consumption. At the same time the highly perishable nature of fresh fish calls for application of preservation techniques to maintain its keeping quality. This course deals with the microorganisms associated with fish and fishery products in their natural environment and as contaminants during capture, handling, processing and preservation, role of microorganisms in spoilage, microorganisms of human health significance, and the intrinsic and extrinsic parameters that regulate the activity of food associated microorganisms. |

| **Semester** | 6 | Credits | | | 4 | Total Hours |
|---|---|---|---|---|---|---|
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge on microorganisms and seafood industry | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understand the history and importance of microorganisms in fish foods. | U | 1,2 |
| 2 | Utilise the knowledge of the microorganisms in fresh and processed fish foods, the factors affecting the microbial growth and their role in food spoilage. | A | 1,2 |
| 3 | Examine the microbes involved in food borne infections and intoxications. | An | 1,2 |

| | | | |
|---|---|---|---|
| 4 | Infer the various ways of fish spoilage and its control. | An | 1,2 |
| 5 | Evaluate the sanitary and quality standards in fish processing industries. | E | 1,2,6,9 |
| 6 | Develop fundamental skills in microbiology and quality assurance of seafood. | A, S | 1,2,5 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | **Significance of microbes in foods and Microorganisms in seafood** | | **17 Hours** | |
| 1 | 1.1 | Role and significance of microorganisms in foods. | 3 | 1 |
| | 1.2 | Basic microbial principles of fish preservation and processing- application of low temperature, high temperature, drying, irradiation and chemicals. | 3 | 1 |
| | 1.3 | Microorganisms in fresh and processed fish – raw fish, chilled fish, frozen fish, cured fish, canned fish, fermented, irradiated, value added and other miscellaneous fish products. | 4 | 1 |
| | 1.4 | Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in fish. | 4 | 2 |
| | 1.5 | Psychrophiles, halophiles and the mesophiles, their role in spoilage and food poisoning. | 3 | 2 |
| 2 | **Microbes of public health concern and fish spoilage** | | **20 Hours** | |
| 2 | 2.1 | Bacteria involved in foodborne infections and intoxications– *Vibrio parahaemolyticus, V. cholerae, Listeria monocytogenes, Clostridium, Salmonella, Shigella, Staphylococcus, E. coli.* | 4 | 3 |
| | 2.2 | Biological hazards associated with fish and fishery products: Marine toxins; mycotoxins, parasites and viruses. | 3 | 3 |
| | 2.3 | Occurrence, growth, survival, pathogenicity, prevention and risk assessment of common bacteria present in fish. | 4 | 3 |
| | 2.4 | Types of spoilage of fish and fish products. Indicators/Indices of fish spoilage. | 3 | 4 |
| | 2.5 | Microbial spoilage of fish/shell fish and its prevention/control | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| | 2.6 | Assessment of quality of fish and fishery products. | 3 | 4 |
| 3 | **Sanitary and Quality management** | | **8 Hrs** | |
| 3 | 3.1 | Bacteria of sanitary significance. | 1 | 5 |
| | 3.2 | Quality Indicators of fish products. Disinfectants, detergents and cleaning schedule. Process water quality in fish processing industries. | 2 | 5 |
| | 3.3 | Concepts of Quality Management; TQM, SSOP, GHP, GMP. | 2 | 5 |
| | 3.4 | Quality standards for fish and fishery products – BIS, FSSAI, Codex Alimentarius, ISO 9000 series and HACCP. Microbiological standards and criteria. | 3 | 5 |
| 4 | **PRACTICALS** | | | **30 Hrs** |
| | 4.1 | Activity : Training in a fish processing plant or in a laboratory of government or private sector research organization to study the isolation, culture and enumeration of microbes in water, ice, fish and fish products, detecting microbes by biochemical tests and molecular methods, assessment of freshness and quality of fresh and processed fish/ shellfish. Submission of a hand written report of the activity. | 10 | 6 |
| | 4.2 | Assessment of freshness of fish and shrimp by using organoleptic characters. | 4 | 6 |
| | 4.3 | Familiarization of common possible bacteria in seafood. | 4 | 6 |
| | 4.4 | Gram staining of bacteria. | 4 | 6 |
| | 4.5 | Determination of available chlorine. | 4 | 6 |
| | 4.6 | Sterilization techniques, Media preparation, Isolation and maintenance of bacteria | 4 | 6 |
| 5 | **Teacher specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks |

| | |
|---|---|
| | **Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

**REFERENCES**


1. Bonell, A. O. (1994). *Quality assurance in seafood processing: A practical guide*. Chapman and Hall.
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**SUGGESTED READINGS**


1. Amerine, M. A., Pangborn, R. M., & Roessler, E. B. (2013). *Principles of sensory evaluation of food*. Elsevier.
2. Anthony, T. T. (1988). *Handbook of natural toxins: Marine toxins and venom* (Vol. III). Marcel Dekker.
3. Balachandran, K. K. (2001). *Post-harvest technology of fish and fish products*. Daya Publishing House.
4. Govindhan, T. K. (1985). *Fish processing technology*. Oxford & IBH Publishing Co.
5. Guthrie, R. K. (1988). *Food sanitation*. Van Nostrand Reinhold.
6. Wheaton, F. W., & Lawson, T. B. (1985). *Processing aquatic food products*. Wiley-Interscience.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fish Pathology, Immunology and Health Management** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG6DSEAQC300** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | Fish Pathology, Immunology and Health Management, provides a comprehensive exploration of finfish and shellfish pathology, various diseases, their causative agents and diagnostic techniques. The course fosters a holistic understanding of aquatic animal health, equipping graduates with the knowledge and skills necessary for effective disease management and prevention in the field of aquaculture. | | | | | |
| **Semester** | 6 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Basic knowledge on Microbiology and cell organization of Microorganisms | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domain | PO No |
|---|---|---|---|
| 1 | Identify various diseases in fish and shell fishes and understand the acquired and | U | 1,2,9 |

| | | | |
|---|---|---|---|
| | innate immune system of finfishes and crustaceans. | | |
| 2 | Implement best management practices and biosecurity principles to maintain aquatic animal health and prevent disease outbreaks in aquaculture | Apply | 1,2 |
| 3 | Apply the principles of disease diagnosis to identify and characterize various diseases. | An | 1,2 |
| 4 | Critically evaluate the efficacy of various therapeutics and disease prevention and management strategies applied at farm level. | E | 1,2,5,10 |
| 5 | Perform conventional diagnostic methods including gross examination, histopathology and microbiology to diagnose finfish and Shellfish diseases. | S | 1,2 |
| 6 | Design protocol/risk assessment plan to identify and mitigate potential disease threats to an aquaculture facility. | C | 1,2,6 |
| *Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to Finfish and Shellfish Pathology and Immunology and Aquatic Animal Health Management** | | **15 Hrs** | 1 |
| | 1.1 | Significance of fish diseases in relation to aquaculture. Definition of health and disease. | 1 | 1 |

| | | | | |
|---|---|---|---|---|
| 1 | | Host, pathogen and environment interaction. | | |
| | 1.2 | Pathophysiology- Stress and General Adaptation Syndrome; the cellular stress response; Inflammatory Response-Acute and chronic. | 3 | 1 |
| | 1.3 | Immunology of Finfishes- Nonspecific Defense Mechanism (Surface Barriers, Nonspecific humoral factors and Non-Specific Cellular factors) and Specific Defense Mechanism (Lymphocytes, Lymphoid organ, Immunoglobulins, cell Mediated Immunity). Immune system of shrimps. Factors affecting immune response. | 4 | 1 |
| | 1.4 | Introduction to aquatic animal health management | 1 | 1 |
| | 1.5 | Disease monitoring, surveillance, quarantine certification (SPF, SPR, SPT) and risk analysis. | 2 | 1 |
| | 1.6 | Fish Vaccine and adjuvants, Vaccine types and Production and Delivery Mechanisms | 1 | 1 |
| | 1.7 | Immunostimulants and nutraceuticals in Fish health | 1 | 1 |
| | 1.8 | Therapeutics and sanitizers used in aquaculture | 1 | 1 |
| | 1.9 | Best Management Practices and biosecurity principles in Aquaculture | 1 | 4 & 6 |
| | **Infectious Diseases, Non-infectious Diseases and Disorders and Parasitic Diseases of Fin and Shell Fishes** | | **15 Hrs** | |

| | | | | |
|---|---|---|---|---|
| 2 | 2.1 | OIE listed and notifiable diseases- Epizootic haemopoietic necrosis, viral hemorrhagic septicemia, Spring viraemia of carp, Epizootic Ulcerative syndrome, Gyrodactylosis, White spot disease, Baculoviral midgut gland necrosis (list out only the disease-causing agent and target tissue) | 1 | 1 |
| | 2.2 | **Bacterial diseases of finfishes** (Etiology, pathogenesis, epidemiology, prophylaxis, treatment and control measures of Aeromonasis and Columnaris; Mention the causative agents, treatments and Control for Furunculosis, Bacterial gill disease, Vibriosis, Mycobacteriosis, Enteric Red Mouth, Edwardsiellosis, Pasteurellosis, Streptococcosis) **and shellfishes**(Mention the causative agent, treatment and control for Vibriosis, Acute Hepatopancreatic Necrosis Disease , Necrotizing, Hepatopancreatitis, Rickettsial diseases, Mycobacteriosis) | 3 | 3&4 |
| | 2.3 | **Viral Diseases of finfishes** (Etiology, pathogenesis, epidemiology and control of Tilapia Lake Virus-TiLV; Mention other viral diseases - Spring Viraemia of Carp-SVC, Viral HaemorrhagicSepticaemia-VHS, Lymphocystis, Koi herpes Virus-KHV, Infectious Salmon Anaemia -ISA, Infectious Haematopoietic Necrosis (IHN), Red Seabream Iridoviral disease) and **Crustaceans** (Etiology, pathogenesis, epidemiologyand control WSSV; mentionother viral diseases-Yellow Head Virus, Infectious Hypodermal and HaematopoieticNecrosisVirus, Monodon Baculovirus, Baculovirus penaei, Baculovirus | 3 | 3&4 |

| | | | | |
|---|---|---|---|---|
| | | Midgut- gland Necrosis, Macrobrachiumrosenbergiinodavirus). | | |
| | 2.4 | **Fungal diseases of finfishes** (Aphanomysis, Cotton wool disease, Branchiomycosis and Aspergillosis, EUS) **and Shellfishes**- Lagenidium, Sirolpidium, Fusarium. | 2 | 3&4 |
| | 2.5 | **Fish Parasites**: Life cycle*oflchthyophthirius;* Pathology, treatment and control of disease caused by protozoan parasite (*Costia, Ichthyophthirius, Myxozoans*), Metazoan parasites (Trematodes- *Dactylogyrus, Gyrodactylus,* cestodes: *Diphyllobothrium*; Nematodes: *Camallanus)*, Crustacean parasites (*Lernea, Argulus, Ergasilus*). Shellfish Parasites: Microsporidian, Haplosporidian, ciliates. | 3 | 3&4 |
| | 2.6 | Nutritional- Amino Acids, Fatty acids, Vitamins and Minerals and Environmental Diseases- water quality related, irritants. | 2 | 1 |
| | 2.7 | Aflatoxins, Ichthyotoxins, Algal blooms and Aquatic pollution | 1 | 1 |
| | **Disease Diagnostic Techniques** | | **15 Hrs** | |
| 3 | 3.1 | Principal of disease diagnosis - Level I (Farm Level/ Farmers level-behavioral changes,Sample collection of gills and mucus) Level-2 (histopathology, bacteriology, virology, water analysis), Level -III- Fast and confirmatory diagnosis of infections | 1 | 3 |
| | 3.2 | Conventional diagnostic methods- Microscopical, microbiological, | 4 | 1 |

| | | | | |
|---|---|---|---|---|
| | | histopathological, hematological and biochemical methods | | |
| | 3.3 | Molecular techniques in disease diagnosis-Single PCR, Real-Time PCR, Quantitative PCR, Reverse Transcription PCR | 3 | 1 |
| | 3.4 | Serological techniques in disease diagnosis-ELISA, Western blotting, Immunodiffusion, Immunoelectrophoresis, Agglutination test, Fluorescent Antibody Techniques, Rapid Immunochromatographic Tests, Hemagglutination and Inhibition tests, Multiplex Immunoassays. | 7 | 1 |
| **PRACTICAL** | | | | **30 Hrs** |
| 4 | 4.1 | On-farm practical sampling sessions and case studies | 5 | 5 |
| | 4.2 | Dose determination and application of therapeutants | 2 | 5 |
| | 4.3 | Preparation of medicated feeds | 2 | 5,6 |
| | 4.4 | Wet mount preparation | 2 | 5 |
| | 4.5 | Identification of diseases and causative agents involved - Bacterial, fungal and parasites | 10 | 3 |
| | 4.6 | Blood collection and haematological techniques | 2 | 5 |
| | 4.7 | PCR, Gel Diffusion, Histopathology, Antibiotic sensitivity test (Demonstration or Visit to Nearby Institutes). | 7 | 1 |
| 5 | | **Teacher Specific Content** | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

## REFERENCES


1. Adams, A. (Ed.). (2016). *Fish vaccines*. Springer.
2. Ayyappan, S. (Ed.). (2018). *Handbook of fisheries and aquaculture*. ICAR.
3. Brown, L. (Ed.). (1993). *Aquaculture for veterinarians*. Pergamon Press.
4. Eldin Eissa, A. (2016). *Clinical and laboratory manual of fish diseases*. LAP LAMBERT Academic Publishing.
5. Halver, J. E. (Ed.). (1972). *Nutritional fish diseases*. Elsevier.
6. Jeney, G. (Ed.). (2017). *Fish diseases: Prevention and control strategies*. Academic Press.
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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Management of Ornamental Fish Culture** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG6DSEAQC301** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | This course delves into the ornamental fish industry, emphasizing the biology, breeding, culture, and management of ornamental fish. It addresses system design, water quality, nutrition, health, breeding methods, and marketing. The aim is to provide students with the skills and knowledge needed for successful ornamental fish management, focusing on sustainability and conservation. | | | | | |
| **Semester** | **6** | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should be familiar with common ornamental fishes and aquaria. | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Identify major ornamental fish species and their ecological requirements, and understand the significance of biodiversity." | **K,U** | **1,2** |

| | | | |
|---|---|---|---|
| 2 | Explain the setup and management of aquarium systems, emphasizing the selection of equipment and species compatibility. | **U** | **1,2** |
| 3 | Apply techniques for maintaining water quality and health management practices in ornamental fish culture | **Ap** | **1,9** |
| 4 | Analyze breeding strategies and genetic selection principles to enhance ornamental fish production. | **An** | **1,10** |
| 5 | Evaluate market trends, regulatory impacts, and sustainability practices within the ornamental fish industry. | **E** | **1,2,9,** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**V**

## COURSE CONTENT

### Content for Transaction

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to Ornamental Fish Culture and Aquarium Management** | | **15 Hrs** | |
| | 1.1 | Overview of Ornamental Fish Industry<br>Importance of Ornamental Fish in Aquaculture | **3** | **1** |
| | 1.2 | Major Marine and Freshwater Ornamental Fish and their ecological needs | **3** | **2** |
| | 1.3 | Introduction to Aquarium and Aquarium Accessories-Aquarium Heater, Thermometer, Air Pump,Air Stone, Heating and Lighting | **3** | **3** |
| | 1.4 | Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes<br>Types of Filtration of water<br>Recirculating Systems | **3** | **2** |
| | 1.5 | Cleaning the aquarium; maintenance of water quality. Control of snail and algal growth<br>Handling, care and transportation of fish. Temperature acclimation, oxygen packing. | **3** | **2** |

| | | | | |
|---|---|---|---|---|
| **2** | **Strategies for the Commercial Production of Ornamental Fishes** | | **20 Hrs** | |
| | 2.1 | Species of ornamental fishes; their taxonomy and biology- Live bearers, Gold fish and koi, Gourami, Barbs ,Angel fish, cichlids | **3** | **1** |
| | 2.2 | Commercial production of goldfish, live bearers, gouramies, barbs, angel fish<br>Maturation, secondary sexual characters, breeding habits, spawning, parental care. Larval rearing | **3** | **4** |
| | 2.3 | Biology, Hatchery and Seed Production of Marine Ornamental Fishes – Clown Fishes | **3** | **4** |
| | 2.4 | Indigenous Ornamental Fishes of Kerala, Seed production of Miss Kerala. | **3** | **1** |
| | 2.5 | Freshwater aquarium Plant sand their propagation | **3** | **2** |
| | 2.6 | Nutritional Requirements, Feeds and Feeding Strategies of Ornamental Fishes. | **5** | **3** |
| **3** | **Marketing, Conservation and Sustainable Practices** | | **10 Hrs** | |
| | 3.1 | Market trends and consumer preferences | **2** | **5** |
| | 3.2 | Export and import regulations | **2** | 5 |
| | 3.3 | Environmental impacts of ornamental fish culture | **2** | 5 |
| | 3.4 | Conservation breeding programs | **2** | 5 |
| | 3.5 | Regulatory frameworks and certifications | **2** | 5 |
| **4** | **PRACTICALS** | | **30 Hrs** | |
| | 4.1 | Identification of commercially important Ornamental Fishes | **3** | **1** |
| | 4.2 | Design and construction of Beginner's Aquarium | **3** | **1** |
| | 4.3 | Testing of pH , ammonia, Nitrite and Nitrate | **3** | **3** |
| | 4.4 | Artemia Hatching, Estimation of Hatching rate at different salinities | **3** | **3** |
| | 4.5 | Preparation and Administration of live and pelleted feeds. | **3** | **3** |
| | 4.6 | Packaging Techniques for Ornamental Fishes | **3** | **5** |
| | 4.7 | Identification of Aquarium Plants | **2** | **2** |

| | | | | |
|---|---|---|---|---|
| | 4.8 | Visit to Ornamental Fish Farm or Trade Centre | **10** | **5** |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 15 Marks<br>• Principle and Procedure = 12 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

**REFERENCES**


1. Andrews, B. (Year). *Ornamental fish farming: Breeding styles in groups of ornamental fish*. Publisher.
2. Bassleer, G. (Year). *Diseases of ornamental fishes: Diagnosis and treatment*. Publisher.
3. Danzmann, R. G., & Aquaculture Genetics Research Group. (Year). *Genetic management of hatchery stocks*. Publisher.
4. Hart, P. J. B., & Reynolds, J. D. (Eds.). (Year). *Handbook of fish biology and fisheries, Volume 2: Fisheries*. Publisher.
5. Hiscock, P. (Year). *Aquarium success*. Publisher.
6. Lewbart, G. A. (Year). *Ornamental fishes and aquatic invertebrates: Self-assessment color review*. Publisher.
7. Nijman, E. (Year). *The ornamental fish trade: An introduction with perspectives for responsible aquarium fish ownership*. Publisher.

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | |
| **Course Name** | **Fisheries Economics and Extension** | | | | |
| **Type of Course** | **DSE** | | | | |
| **Course Code** | **MG6DSEAQC302** | | | | |
| **Course Level** | **300** | | | | |
| **Course Summary** | The course in Fisheries Economics and Extension provides a comprehensive exploration of the economic principles and extension strategies applied in the context of fisheries management and development. Designed to equip students with a deep understanding of the economic aspects of fisheries, as well as effective extension techniques. | | | | |
| **Semester** | 6 | Credits | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others |
| | | 4 | | | 60 |
| **Pre-requisites, if any** | Students should possess basic understanding of social sciences and critical thinking skills | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understanding of economic principles relevant to fisheries. | U | 1,2 |

| | | | |
|---|---|---|---|
| 2 | Understand the functions of fishermen cooperatives, village societies, producing and marketing apex societies and address financing and special problems with remedial measures. | U | 6,7 |
| 3 | Design and implement effective fisheries extension programs, utilizing communication and behaviour change theories to engage with communities and stakeholders. Design informative and engaging extension materials, including bulletins, leaflets and booklets. | C,S | 3,6,7,9 |
| 4 | Analyze and present case studies on social, gender issues and conflicts within the fisheries contexts. | An | 1,2 |
| 5 | Foster community engagement by integrating participatory approaches and addressing social and cultural factors in fisheries management. | C, S, E | 4,5,6 |
| 6 | Evaluate the economic viability of a aquaculture unit-(Planning and Budgeting). | E | 7,9 |
| *Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)* | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | 15 Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to Economics and Fisheries Co-operatives** | | | |
| 1 | 1.1 | Economics-definition, scope and role. Basic concept of economics -goods, services, wants, utility. Demand and Supply, Individual | 5 | 1 |

| | | | | |
|---|---|---|---|---|
| | | demand, Market demand,Value based Pricing and Cost Based pricing. | | |
| | 1.2 | Elasticity of demand, Law of diminishing marginal utility. | 2 | 1 |
| | 1.3 | Co-operation- basic principles, co-operative legislation and its administrative structure. | 2 | 1,2 |
| | 1.4 | Fishermen co-operatives, its functions, village societies, producing and marketing apex societies. Financing and special problems of fishermen cooperatives and remedial measures.<br>Activity: Case study on social/gender issues and social conflicts in fisheries. | 3 | 1,2 |
| | 1.5 | Role of National Co-operative Development Corporation, KVK, ADAK, NIFAAM,Matsyafed, FISHCOPFED, NFDB, MPEDA, and NABARD in uplifting the socio- economic conditions of fishermen. | 3 | 1,2 |
| | | **Feasibility Studies Hours** | **15 Hrs** | |
| 2 | 2.1 | Feasibility Analysis in fisheries Project- Introduction to Feasibility Analysis (Definition and importance).<br>Identify the components of feasibility studies (Technical, Economical and Financial aspects).<br>Undiscounted measures of Project Worth (Ranking by inspection, Payback Period).<br>Time Value of Money.<br>Discounted Measures of Project Worth (Discounted payback period, Net present worth-NPW, Benefit-cost ratio- BC Ratio). | 9 | 2 |

| | | | | |
|---|---|---|---|---|
| | | Internal Rate of Return- Understanding IRR, Decision criteria based on IRR. | | |
| | 2.2 | Risk and uncertainty.<br>Sensitivity Analysis- Partial sensitivity analysis, Best Worst Scenario Analysis, Monte Carlo Analysis.<br>*Activity*: Economic valuation studies to estimate the economic value of fisheries, resources, including the value of fish stock for commercial and recreational purposes- Collect fish landing/culture data and analyze its impact on Indian economy | **6** | |
| | **Cost and Returns in Fisheries** | | **15 Hrs** | |
| 3 | 3.1 | Break Even Analysis in fisheries<br>Cost Concepts- Variable Cost, Fixed Cost, Total Cost, Junk Cost, Average Cost, Marginal Cost, Opportunity cost | 8 | 1,2 |
| | 3.2 | Farm planning, budgeting- Complete and Partial budgeting.<br>Activity: Evaluate the economic viability of an Aquaculture unit-(Planning and Budgeting). | 7 | 1,2 |
| | **Fisheries Extension and Teaching Methods** | | **15 Hrs** | |
| 4 | 4.1 | Introduction to Fisheries education and fisheries management- Meaning objectives, principles, importance and scope in fisheries<br>Activity: Communication Skills- Public speaking | 3 | 1,2 |

| | | | | |
|---|---|---|---|---|
| | 4.2 | Fisheries Extension Methods- Individual, group and mass contact methods, their effectiveness, factors influencing their selection and use<br><br>Activity: Make a radio talk on any fish farming technique or any fishery related event- Mass Communication technique<br><br>Make a video reel on any farming technique/ value addition in fish or activity of a fishing village- Mass communication technique | 4 | 1,2 |
| | 4.3 | Extension Program Planning and Evaluation- Steps and importance, participatory planning process<br><br>Study of social issues/ problems through participatory and rapid rural appraisal techniques<br><br>Prepare Questionnaire, Collection of socio-economic data from fishing villages | 4 | 1,2 |
| | 4.4 | Extension Teaching methods- Selection, Planning, use, demonstration, exhibition, farmer fairs, field days, tours<br><br>**Activity: Design Posters or Flip Charts**<br><br>Design extension materials: bulletins, leaflets, booklets | 4 | 1,2 |
| 5 | | Teacher Specific Content | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12)<br>10 X 2=20 Marks |

| | |
|---|---|
| | • Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

## REFERENCES


1. BOS Institute of Chartered Accountants of India. (2007). *General economics*. Institute of Chartered Accountants of India.
2. Chandrasekhar (Ed.). *Privatization of agricultural extension in India*. MANAGE, Hyderabad.
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4. Jhinga, M. L. (2004). *Principles of economics* (2nd ed.). Vrinda Publications.
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10. Van Den Ban, A. W., & Hawkins, H. S. J. (2002). *Agricultural extension* (2nd ed.). CBS Publishers, Delhi.

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fish Biochemistry** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG6DSEAQC303** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | This course delves into the biochemical constituents of aquatic life, covering the intricate biochemistry of proteins, lipids, and enzymes found in fish, crustaceans, and molluscs. It explores their structural, functional, and post-mortem changes, alongside the preparation and properties of marine polysaccharides, emphasizing the practical applications and impacts of these biochemical processes on seafood quality and nutrition. | | | | | |
| **Semester** | **6** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Activities | |
| | | 4 | | | | 60 |
| **Pre-requisites, if any** | Students should have a preliminary knowledge of organic chemistry and Biochemistry | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Understand the biochemical constituents of fish, crustaceans, and mollusks, including their proteins and lipids. | **U** | **1,2,3** |
| 2 | Analyze the structural and functional properties of seafood proteins and lipids, Nucleic Acids and Vitamins, understanding their importance in nutrition and food processing. | **An** | **1.,9,10** |
| 3 | Evaluate the impact of post-mortem biochemical changes and processing methods on the quality of seafood. | **E** | **1,2** |

| | | | |
|---|---|---|---|
| 4 | Apply knowledge of enzymatic reactions, including kinetics and mechanisms, to assess seafood quality and shelf-life. | **A** | **1,3** |
| 5 | Investigate the roles of polysaccharides in seafood, focusing on the preparation and applications of chitin, chitosan, and glucosamine. | **An** | **2** |
| 6 | Synthesize knowledge of antioxidants, oxidation indices, and enzyme classifications to develop strategies for preserving seafood quality. | **C** | **1,9,10** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Biochemical Composition of Fish** | | **12 Hrs** | |
| | 1.1 | Biochemical constituents of fish, crustaceans and mollusks. | **3** | **1** |
| | 1.2 | Biochemistry of fish proteins, Classification. Sarcoplasmic proteins, Myofibrillar proteins and Stroma proteins | **3** | **1** |
| | 1.3 | Structure of fish muscles and Post mortem biochemical changes, rigor mortis | **3** | **1** |
| | 1.4 | Non-protein nitrogenous compounds, K value | **3** | **1** |
| **2** | **Proteins and Nucleic Acids** | | **12 Hrs** | |
| | 2.1 | Functional properties of seafood proteins: Solubility, emulsification, viscosity, water holding, stability, gelation, | **3** | **2** |
| | 2.2 | Precipitation of proteins, Salting in and Salting out<br>Denaturation and coagulation of proteins<br>Changes in proteins during processing | **3** | **2** |
| | 2.3 | **Nucleic Acid Chemistry:**<br>Classification; Types of DNA and RNA, Metabolic functions of nucleotides, | **3** | **2** |
| | 2.4 | Sense and antisense RNA, RNA interference; Cistron, | **3** | **2** |

| | | | | |
|---|---|---|---|---|
| | | Operon and transposon; RNA splicing, miRNA and lnRNA. | | |
| **3** | **Seafood Lipids and Vitamins** | **21 Hrs** | | |
| | 3.1 | Seafood lipids: Composition and nutritive value<br>Triglycerides, phospholipids, Non-saponifiables including sterols and vitamins. | **5** | **2** |
| | 3.2 | Classification and naming of fatty acids,<br>MUFA, PUFA, HUFA , Omega 3 Fatty acids<br>Lipases and Phospholipases | **4** | 2 |
| | 3.3 | Auto-oxidation of fatty acids, rancidity<br>Pro- and anti-oxidants,<br>Oxidation indices, Peroxide value , TBA Value, FFA value | **4** | 6 |
| | 3.4 | **Vitamins:**<br>Classification, Active forms of vitamins, Types of vitamins and essential minerals | **4** | 2 |
| | 3.5 | Deficiency syndromes of vitamins and minerals;<br>Clinical significance of vitamins and essential minerals. | **4** | 2 |
| **4** | **Enzymes and Polysaccharides** | **15 Hrs** | | |
| | 4.1 | Structure and function of enzymes | **3** | **4** |
| | 4.2 | Kinetics of enzyme activity, KM value,Turnover number, | **3** | **4** |
| | 4.3 | Mechanism of Enzyme activity | **3** | **4** |
| | 4.4 | Classification of enzymes<br>Ribozymes, Abzymes, Synthetic enzymes, Co – enzymes, Cofactors and Prosthetic groups | **3** | **4** |
| | 4.5 | **Polysaccharides:** Naming and classification, Preparation of Chitin, Chitosan and Glucosamine | **3** | **5** |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

**REFERENCES**


1. Connell, J. J. (Year). *Advances in fishery science and technology*.
2. Gopakumar, K. (Year). *Fish processing technology*. ICAR.
3. Halver, J. E., & Hardy, R. W. (Eds.). (Year). *Fish nutrition*.
4. Hochachka, P. W., & Mommsen, T. P. (Eds.). (Year). *Biochemistry and molecular biology of fishes*.
5. Merrifield, D., & Ringø, E. (Eds.). (Year). *Aquaculture nutrition: Gut health, probiotics, and prebiotics*.
6. Vance, D. E., & Vance, J. E. (Year). *Fish biochemistry*.

# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Preparation of Artificial Fish Feed in Aquaculture** | | | | | |
| **Type of Course** | **SEC** | | | | | |
| **Course Code** | **MG6SECAQC300** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | The course mainly focus on introduction to feed requirements of Fish, **Raw materials for artificial fish feed,** Feed Formulation Techniques , Types of feeds and measurement of calorific value, Feed Manufacturing equipments, additives and supplements. | | | | | |
| **Semester** | **6** | Credits | | | **3** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | | | 45 |
| **Pre-requisites, if any** | Students should possess knowledge regarding general characters of fishes , digestive system of fishes, feeding behaviour of fishes. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Understanding aquaculture Feed and its significance. | U/C | 1,2 |
| 2 | Identifying nutritional needs of various fish species | A | 1,2 |
| 3 | Exploring primary ingredients for fish feed | An | 1,2 |
| 4 | Understanding essential nutrients for fish growth and health. Acquire skills of various | U/E | 1,2 |

| | | | |
|---|---|---|---|
| | manufacturing process like extrusion, grinding pelleting etc, Evaluating the nutritional balance of the various artificial feeds. | | |
| 5 | Understanding the role of probiotics and pre biotics in fish nutrition. Understanding the purpose and types of additives. | U/E | 1,2 |
| 6 | Develop fundamental skills in the preparation of artificial feeds | A, S | 2,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | **Introduction to Feed Requirements of Fish 12 Hrs** | | | |
| | 1.1 | Nutritional needs of various fish species , Basics of fish feed composition | **3** | **1** |
| | 1.2 | Economic significance feed usage in Aquaculture, environmental considerations regarding fish feed in aquaculture. | **3** | **1** |
| | 1.3 | Feed Conversion Ratio(FCR), Food Efficiency Ratio(FER) | **3** | **1** |
| | 1.4 | Factors affecting digestibility, immunostimulants, growth promoters, preservatives. | **3** | **1** |
| **2** | **Raw Materials for Artificial Fish Feed Preparation and Feed Formulation Techniques** | | **15 Hrs** | |
| | 2.1 | Raw materials of plant origin , raw materials of animal origin , non conventional materials<br>**Activity:** Identification of Feed Ingredients of Plant and Animal Origin | **3** | **2** |
| | 2.2 | Protein and amino acid requirement, carbohydrate and lipid requirement, Essential fatty acids, Non protein nitrogen Sources.Vitamin and mineral requirements, vitamin C for fish and shell fishes. | **3** | **2** |
| | 2.3 | Principles of feed formulation – Pearson's square method, Linear programming, Proximate analysis | **3** | **3** |

| | | | | |
|---|---|---|---|---|
| | | **Activity** – prepare different feed formulation with two ingredients using pearson's square . | | |
| | 2.4 | Types of feeds- Wet feeds, dry feeds , moist feeds Larval feeds – Minced diets, microparticulate diets, spray dried diets, microbound diets, micro coated diets and microencapsulated diets | **3** | **3** |
| | 2.5 | Measurement of calorific value – Component analysis, Wet oxidation , Bomb Calorimetry. | **3** | **3** |
| **3** | **Types of Feeds, Feed Manufacturing Equipments** | | **18 Hrs** | |
| | 3.1 | Different forms of feed-fodders, mash, pellets, floating and sinking feeds. Feedformulation - methods, square method. Dry Feed manufacturing processes, Extrusion, Palletization , Different size and grades of fish / shrimp feeds - starter, grower and finisher feeds. | **4** | **4,5** |
| | 3.2 | Micro-bound feed, micro encapsulated feed. Storage and transportation of feeds. Quality problems- toxins, pests, rancidity | **4** | 4,5 |
| | 3.3 | Equipments used in feed preparation – Oven/dryers , pelletizer, feed press , die plate , extruder, grinders, mixers, coolers, elevators , crumbler , feed mills<br>**Activity** – visit a feed manufacturing unit and submit a brief report | **4** | 4 |
| | 3.4 | Additives – definitions , types – binders , anti oxidants, pigments, anabolic agents , antimicrobials and health supplements<br>Role of additives in immune health and stress reduction. | **3** | 4 |
| | 3.5 | Enzymes, probiotics, pre biotics. Importance of emulsifiers and stabilizers. | **3** | 5 |
| **4** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | **lecturing with ICT Activities** |
| **Assessment Types** | **MODE OF ASSESSMENT**<br><br>**A. Continuous Comprehensive Assessment (CCA)**<br>• Theory- 25 Marks |
| | **B. Semester End Evaluation (ESE)**<br><br>**Theory**<br>• Very Short Answer Questions (10 out of 12):10X 1=10<br>• Short Answer Questions (6 out of 9): 6x5=30<br>• Essay (1 out of 3):1 X 10= 10 Marks<br>• Total – 50 Marks |

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# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Preservation Techniques for Aquatic Specimens and Museum Collections** | | | | | |
| **Type of Course** | **SEC** | | | | | |
| **Course Code** | **MG6SECAQC301** | | | | | |
| **Course Level** | **300** | | | | | |
| **Course Summary** | The course provides in-depth training in preserving aquatic specimens, combining traditional and advanced techniques with a focus on ethical practices and conservation. It prepares students for roles in museum curation and aquatic research. | | | | | |
| **Semester** | **6** | Credits | | | **3** | |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | Total Hours |
| | | 3 | | | | 45 |
| **Pre-requisites, if any** | Students should possess knowledge about basic preservatives and Preservation Techniques for organisms. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Understand the fundamentals and importance of aquatic specimen preservation. | U | **1,2** |
| 2 | Apply basic principles of taxonomy and classification in the context of specimen preservation. | Ap | **1,2,9** |
| 3 | Design educational and engaging museum displays incorporating modern technology. | C | **1,2** |

| | | | |
|---|---|---|---|
| 4 | Master various chemical and physical preservation techniques for aquatic specimens. | Ap | **1,2** |
| 5 | Utilize advanced preservation techniques, including non-invasive imaging and digital preservation. | An | **1,2,3** |
| 6 | Develop skills in specimen preparation, cataloging, and exhibition, adhering to ethical considerations. | C | **1,3** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to Aquatic Specimen Preservation and Museum Display Techniques 12 Hrs** | | | |
| | 1.1 | Overview of Aquatic Specimen Preservation,<br>History and Importance of Specimen Preservation in Museum | **3** | **1** |
| | 1.2 | Basic principles of Taxonomy and Classification,<br>Ethical Considerations in Specimen Collection and Preservation | **3** | **2** |
| | 1.3 | **Museum Display Techniques:**<br>Designing Educational and Engaging Displays,<br>Lighting and Climate Control for Aquatic Displays | **3** | **3** |
| | 1.4 | Interactive Displays: Incorporating Technology in Exhibits,<br>Maintenance of Live Aquatic Exhibits | **3** | **3** |
| **2** | **Techniques in Aquatic Specimen Preservation 18 Hrs** | | | |
| | 2.1 | **Preservation Techniques:**<br>Chemical- Formalin , Alcohol<br>Freeze Drying and Cryopreservation Techniques<br>Embedding Techniques , Plastics and Resins | **4** | **5** |
| | 2.2 | Skeleton preparation: Cleaning and Assembly | **3** | **5** |

| | | | | |
|---|---|---|---|---|
| | | | | |
| | 2.3 | Tissue Sampling and DNA preparation | **3** | **5** |
| | 2.4 | Photographic Documentation of Aquatic Specimens<br>Creating Replicas: Molds and Casts | **4** | **6** |
| | 2.5 | Labeling and Cataloguing Specimens<br>Storage and Long-term Care of Preserved Specimens<br>Activity: Museum Visit | **4** | **6** |
| **3** | **Advanced Preservation Techniques for Aquatic Specimens 15 Hrs** | | | |
| | 3.1 | Microscopic Techniques for Aquatic Organisms | **3** | **5** |
| | 3.2 | Anoxic Preservation Techniques | **3** | 5 |
| | 3.3 | 3D Scanning and Digital Preservation | **3** | 6 |
| | 3.4 | Non-invasive Imaging Techniques | **3** | 5 |
| | 3.5 | Preservation of Large Aquatic Animals | **3** | 4 |
| **4** | **Teacher Specific Module** | | | |
| | | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks |

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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Socioeconomic upliftment through fisheries** | | | | | |
| **Type of Course** | **VAC** | | | | | |
| **Course Code** | **MG6VACAQC300** | | | | | |
| **CourseLevel** | **300** | | | | | |
| **Course Summary** | Socioeconomic upliftment through fisheries is an inevitable part of nation building as the fisheries sector makes a valuable contribution to economic and social development of rural areas. The course content aims to make the students understand about the socioeconomic and socio-demographic profiles of fishermen community and its impact on the productivity of fisheries and their livelihood. Economic valuation provides a means for measuring and comparing the various benefits of fisheries resources and their ecosystems, and can be a powerful tool to aid and improve their wise use and management. | | | | | |
| **Semester** | **6** | Credits | | | **3** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | | | 45 |
| **Pre- requisites, if any** | It is desirable for the students to have a social awareness of the different communities of people living around them and a basic knowledge of Fisheries and its contribution towards the economy. | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Introduce socio-economic perspectives of fisheries sector. | U | 1,2 |
| 2 | Analyze the condition of a fishing village. | An | 1,2, 4 |

| | | | |
|---|---|---|---|
| 3 | Understand the role of aquaculture in rural development. | U | 1 |
| 4 | Awareness about the role of fishery cooperatives in developing nations. | Ap | 1,2 |
| 5 | Decipher the role of different agencies in entrepreneurship development. | U, E | 1,2 |
| 6 | Awareness about social responsibility and develop fundamental skills in writing a report. | E, C, S | 4,6, 10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to the socioeconomic condition of fishermen community** | | **17 Hours** | |
| | 1.1 | Introduction to the socioeconomic condition of fishermen community. | **3** | **1** |
| | 1.2 | **Activity:**<br>• **Preparation of questionnaires for socioeconomic survey.**<br>• **Conduct of socioeconomic survey of nearby fishermen community** | **6** | **6** |
| | 1.3 | Economy of fishermen: Fishermen populations, Fishing villages | **4** | **1** |
| | 1.4 | GDP from fisheries sector, foreign exchange earnings and employment potential of fishing industry& fishing villages. | **4** | **1** |
| **2** | **Prospective of Aquaculture in Socio-Economic impact & Rural Development, Marketing of Fish and Fishery Products** | | **18 Hours** | |
| | 2.1 | Resource use and development, Socio-economic analysis | **3** | **2** |
| | 2.2 | Socio-demographic profile, work contribution, household expenditure, income contribution, decision | **4** | **2** |

| | | | | |
|---|---|---|---|---|
| | | making, female headed household, impact of different age groups. | | |
| | 2.3 | Markets and their kinds. Price determination, problems of fish marketing in India. | **3** | **3,4** |
| | 2.4 | Exports of fish and fishery products, recent trends. | **3** | **3,4** |
| | 2.5 | Role of MPEDA in exports of fish and fishery products. | **2** | **3,4** |
| | 2.6 | Role of other Govt. institutions - NFDB, NABARD, State Fisheries Department | **3** | **3,4** |
| **3** | **Fishery co-operatives and Entrepreneurship Development** | | **10 Hours** | |
| | 3.1 | Functions, financial assistance, input supplies, marketing of fish. | **1** | **4** |
| | 3.2 | Role of fisheries corporations and Missionary Organizations in fisheries development. | **1** | **4** |
| | 3.3 | Agencies and schemes providing assistance to self-help groups involved in fisheries sector. | **1** | **5** |
| | 3.4 | Success stories of aquaculture practice/ processing units/feed preparation units managed by self-help groups. | **2** | **5** |
| | 3.5 | **Activity: Visit to any unit pertaining to fisheries sector managed by self-help groups and write a report.** | **5** | **6** |
| **4** | | **Module 4: Teacher Specific Content** | | |

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| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks |

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# SEMESTER 7

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Biophysics, instrumentation and micro techniques** | | | | | |
| **Type of Course** | **DCC** | | | | | |
| **Course Code** | **MG7DCCAQC400** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | Biophysics, instrumentation, and micro technique are three important topics in life science that are interrelated and have significant applications in the field of aquaculture and fisheries. Biophysics is the study of biological systems using the principles of physics. It helps us to understand the physical properties of biological systems and how they function. Instrumentationrefers to the development and application of various tools and techniques used to study and measure biological systems. They help in in collecting data, making observations, and conducting experiments in research. Micro technique is a set of methods used to prepare micro-objects for studying. It is currently being employed in many fields in life science. The combination of these three topics is essential in the study of biological systems at the molecular and cellular level. They help us understand the physical and chemical properties of biological systems and how they interact with each other. | | | | | |
| **Semester** | 7 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess knowledge regarding basic principles and laws of Physics and familiarity with common instruments used in laboratories. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No: | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Utilize the basic principle related to osmosis and diffusion for the better management of aquaculture systems | A | 1, 2 |
| 2 | Create awareness about the principle and working of instruments required in the field of aquaculture and fisheries research. | C | 2, 10 |
| 3 | Examine the anatomic structures with the help of micro techniques | An | 2, 9 |
| 4 | Develops skill to prepare specimens and operate microscopes. | A | 9,10 |
| 5. | Understand the principle and working of microscopes. | U | 3, 9, 10 |
| 6. | Evaluate the various separation techniques used for the separation of biological molecules. | E | 1,2,3,9,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| 1 | **Diffusion and Osmosis** | | **12 Hrs** | |
| 1 | 1.1 | Diffusion, concentration gradient and Fick's Law, diffusion coefficient, stocks-Einstein equation, pressure gradient and Graham's Law, Gibbs-Donnan equilibrium. | 5 | 1 |
| | 1.2 | Osmosis, Vant Hoff's Law, Osmotic concentration and osmotic pressure, biological significance of osmosis in fishes. | 3 | 1 |
| | 1.3 | Biophysics of cell membrane, Different models, their structure,Physics-chemical properties of cell membrane, factors affecting the passage of materials across cell membranes. | 4 | 1 |

| | | | | |
|---|---|---|---|---|
| 2 | **Instrumentation and Microtechniques** | | 23 | |
| | 2.1 | Colorimetry, spectrophotometry- U.V. visible, IR double beam, atomic absorption, Mass spectroscopy,Raman spectroscopy FT-IRand LC-MS, Atomic Absorption spectroscopy | 4 | 2 |
| | 2.2 | pH meter: Standardization of pH meter,Preparation of Buffers; conductivity meter, salinometer and refractometer. | 4 | 2 |
| | 2.3 | Principles of microscopy;Different types of microscopes and their principles (bright field, dark field and phase contrast, confocal, fluorescence) microphotography.Electron microscope principle, types, ultrastructure studies using electron microscopy. | 7 | 2,4,5 |
| | 2.4 | Preparation of tissue for light microscopy-Fixation, Dehydration methods, embedding, clearing, sectioning and Staining.Preparation of whole mounts, smear and squash.Fixation and processing of tissues for electron microscopy studies. | 7 | 3,4 |
| | 2.5 | Micrometry – Occular, Stage, Caliberation and measurement | 1 | 3 |
| 3 | **Separation techniques** | | 10 | |
| 3 | 3.1 | General principle of Chromatography, Different types (absorption, partition, ion exchange, affinity, high performance/pressure liquid chromatography,gas and gel filtration). | 4 | 2,6 |
| | 3.2 | Electrophoresis**:** General principles, Methodology & Applications of Electrophoresistechniques, paper, agarose gel, polyacrylamide gel (native and SDS) electrophoresis & isoelectric focusing. | 4 | 2,6 |
| | 3.3 | Centrifugation: basic principle and different types.<br>Centrifugation techniques-Differential centrifugation, principle, design, types andapplications of different Centrifuges. | 2 | 2,6 |
| 4 | **Practicals** | | **30 Hrs** | |
| | 4.1 | Measure the diameter of fish egg by micrometry | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| | 4.2 | Preparation of whole mounts, smear and squash | 3 | 3 |
| | 4.3 | Preparation of tissue sections for light microscopy- Fixation, Dehydration methods, embedding, clearing, sectioning and Staining. | 15 | 3 |
| | 4.4 | Measure the water pH by pH meter<br>Measurement of Salinity by Salinometer and Titration Measure the concentration of colored solution by colorimetry. | 8 | 2 |
| | 4.5 | Preparation of materials for Column Chromatography and Thin Layer Chromatography | 2 | 5 |
| **5** | | **Teacher specific Content** | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Field Visits<br>Practicals |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Lab Report = 5 Marks<br>• Identification of Spotters = 10 Marks<br>• Principle and Procedure = 17 Marks<br>• Viva = 3 Marks<br>• Total – 35 Marks |

## References


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# Mahatma Gandhi University

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|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | |
| **Course Name** | **Fish population dynamics** | | | | |
| **Type of Course** | **DCC** | | | | |
| **Course Code** | **MG7DCCAQC401** | | | | |
| **Course Level** | **400** | | | | |
| **Course Summary** | A course on fish stock assessment typically covers various methodologies, tools, and techniques used to evaluate and manage fish populations in aquatic ecosystems. | | | | |
| **Semester** | 7 | Credits | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practicals | Others | |
| | | 4 | - | - | - | 60 |
| **Pre-requisites, if any** | Students should possess knowledge in basic science and Mathematics | | | | |



## COURSE OUTCOMES (CO)



| CO No. | Expected Course Outcome | Learning Domain s | PO No |
|---|---|---|---|
| 1 | Mastery in understanding population dynamics and different types of fish stocks | U | 1,2 |
| 2 | Competency in applying sampling methodologies for fishery data collection and abundance estimation. | A | 1,2 |
| 3 | Comprehensive understanding of growth dynamics in fish populations and proficiency in assessing and estimatingmortality rates | U, A, C | 1,2 |

| | | | |
|---|---|---|---|
| 4 | Mastery in using various prediction models to forecast fish population trends and competency in employing trophic and ecosystem-based models to study complex interactions within marine ecosystems. | An,C | 1,2 |
| 5 | Develops skill for using software like FiSATand R programming for fish stock assessment. | **A, S** | 1,2 |
| 6 | Understanding the various types and impacts of overfishing and analyzing the role of regulatory measures in sustainable fisheries management | U, C | 2,10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

## COURSE CONTENT

### Content for Classroom transaction (Units)

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Introduction to fish population dynamics** | | | **14 Hours** |
| 1 | 1.1 | Introduction: population, dynamics, population dynamics, stock assessment | 2 | 1 |
| | 1.2 | Distribution and types of stock - unit stock-mixed stock-straddling stock | 2 | 1 |
| | 1.3 | Characterization of stock (life history traits, truss network, environmental signals, otolith shape; genetic analyses, applied marks); Principle and general procedure of fish stock assessment | 2 | 1 |
| | 1.4 | Principles of stock assessment: Aims, fish abundance, surplus production, production functions | 2 | 1 |
| | 1.5 | Sampling techniques: Collection of fishery data, Field procedure, Abundance estimation, Transect Study, Sampling-survey, Fish landing centre, Exploratory survey, Fishery independent survey, non-extractive abundance sampling, Catch effort assessment<br>*Activity- A field trip to nearby fish landing centre. Collection of fishery data at landing centres from different gears separately. Collection of length frequency data for various groups of finfish and shellfish.* | 6 | 2 |
| | **Growth models** | | | **19 Hours** |

| | | | | |
|---|---|---|---|---|
| 2 | 2.1 | Growth parameters: Length of infinity, Growth coefficient, VBGF equation | **3** | **3** |
| | 2.2 | Principles of growth; Growth parameter estimation Gulland and Holt Plot, Ford – Walford plot & Chapman's method, Chapman's method, | 4 | 3 |
| | 2.3 | Mortality parameters; Types of mortality; Estimation of total, natural and fishing mortality rates, Exploitation ratio, Exploitation rate *Activity: Estimation of age and growth based on length frequency data. Growth, mortality, population and stock parameters employing computer based software (FiSAT)* | 8 | 3 |
| | 2.4 | Recruitment and gear selectivity: Timing and size of recruitment | 2 | 3 |
| | 2.5 | Factors influencing recruitment; Principle and estimation of gear selectivity – trawl netand gill net selectivity | 2 | 3 |
| | **Fish stock assessment models Hours** | | | **21** |
| 3 | 3.1 | Analytical models: Cohort dynamics and life history; Virtual population analysis; | 2 | 4 |
| | 3.2 | Prediction models (Thompson and Bell model; Yield per recruit model and Relative Yield per Recruit model) | 3 | 4 |
| | 3.3 | Surplus production models / Holistic models: Schaefer's model, Fox model,Swept area method, | 3 | 4 |
| | 3.4 | Trophic models:Ecosystem based models– Principles, Applications, Ecopath with Ecosim | 3 | 4 |
| | 3.5 | Software's: Software for fish stock assessment, Computer based software's, FiSAT, Monte Carlo simulations *Activity- Estimate growth, mortality and exploitation pattern of a species using FiSAT software* | 6 | 5 |
| | 3.6 | R program: basics- Application of R program in fisheries. Troph Fish R Software. | 4 | 5 |
| | **Fisheries Management** | | | **6 hours** |

| | | | | |
|---|---|---|---|---|
| 4 | 4.1 | Overfishing- Growth overfishing, Recruitment overfishing, Ecosystem over fishing, regulatory measures | 2 | 6 |
| | 4.2 | CPUE- fishing effort, catchability coefficient | 2 | 6 |
| | 4.3 | Open access fishery, fisheries regulations, current regulatory objectives | 2 | 6 |
| 5 | **Teachers Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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| | |
|---|---|
| **Programme** | **BSc (Hons) Aquaculture** |
| **Course Name** | **Aquatic Toxicology** |
| **Type of Course** | **DCC** |
| **Course Code** | **MG7DCCAQC402** |
| **Course Level** | **400** |
| **Course Summary** | Toxicants are harmful substances introduced into the environment from various sources like agricultural, Industrial and Domestic wastes. Aquatic organisms can accumulate these toxins in their tissues, causing deleterious effects on their consumers. A knowledge on the introduction of toxicants into the environment, their integration into ecological cycles and the harmful effects produced by them is essential in taking up mitigating and remedial measures. This course provides an insight into aquatic toxicants, factors influencing their toxicity, methods of detection and amelioration and the safety measures needed to be taken. As such , the course is imperative for a student of Aquaculture and Fisheries Science. |

| **Semester** | 7 | Credits | | | | Total Hours |
|---|---|---|---|---|---|---|
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | - | - | | 60 |
| **Pre-requisites, if any** | Students from diverse backgrounds, including biology, environmental science, chemistry, geology, or related disciplines, may find this course relevant to their academic interests and career goals. Even if they don't match the requirements, students who are really interested in the subject could still be eligible to enrol. | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| | On completion of this course the student should be able to:Knowmain classes of toxic agents in water bodiestoxicological processes in water bodies | U,An | 1,5,6 |

| | | | |
|---|---|---|---|
| 2 | Analyse main effects of toxic agents | An | 2, 6, 8 |
| 3 | Develop skills for the assessment of water pollution | An,S | 1, 6, 8 |
| 4 | Analyse and evaluate fish stress | An, E | 2, 8 |
| 5 | Evaluate the dyanamics of radiotoxicity and develop skills in the usage of instruments related to radiotoxicity measurements | E,S | 1, 6, 8 |
| ***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Toxicity** | | **15 Hours** | |
| 1 | 1.1 | Toxicology:Definitions, Branches of Toxicology, Historical developments,. Major Types of aquatic toxicants and its deleterious effects. | 2 | 1 |
| | 1.2 | Factors influencing toxicity- environmental, genetic and nutritional | 2 | 1 |
| | 1.3 | Measurement and evaluation of the ecological effects of toxicants; Genotoxicity; neurotoxicity | 4 | 1 |
| | 1.4 | Toxicology of emerging contaminants, PBDE (PolyBrominated DiphenylEther ), New generation pesticides and antibiotics. | 4 | 1 |
| | 1.5 | Antibiotic resistance- Antibiotics – use and misuse including the development of antibiotic-resistant bacteria; AMR, WHONET and ATLAS; Regulatory bodies: safety regulations at national and international levels | 3 | **1** |
| **Metabolism and Xenobiotics** | | | **15Hours** | |
| **2** | 2.1 | Metabolism: Metabolism of toxic substances by aquatic microbes and other organisms - consequences, synergistic and antagonistic effects; Acute poisons and accumulative poisons. | 3 | 2,6 |

| | | | | |
|---|---|---|---|---|
| | 2.2 | Bioaccumulation, bioconcentration and biomagnification; Systemic effects of toxic metals; pesticides and herbicides | 2 | 2,6 |
| | 2.3 | Effect of selected toxicants on aquatic life and detoxification mechanisms | 2 | 2,6 |
| | 2.4 | Interaction of pollutants with abiotic factors (e.g., temperature, pH, dissolved oxygen). Synergistic and antagonistic effects of multiple pollutants. Implications for assessing and managing environmental toxicity. Role of biofilter organisms in water quality maintenance | 3 | 3 |
| | 2.5 | Chemotherapeutic agents: antiprotozoal agents, ectoparasiticide, antihelmenthic, anaesthetics. | 3 | 3 |
| | 2.6 | Antimicrobial drugs: antibacterial, antifungal, antiviral drugs and their delivery system. | 2 | 3 |
| **Toxicity evaluation** | | | **15 Hours** | |
| 3 | 3.1 | Toxicity Testing - Microcosm and Mesocosm Tests; Response Relationships; Toxicity Bioassay.Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetics, Toxicodynamics<br>**Activity:**<br>**1. Toxicity Testing with Aquatic Organisms** -Select a standard test organism and expose them to different concentrations of a toxicant. Monitor and record mortality, growth, and behavioral changes over a specified time period. Calculate LC50 (lethal concentration for 50% of the population) | 4 | 4 |
| | 3.2 | Toxicity evaluation of heavy metals on selected organisms by bioassay techniques;<br>Toxicity assessment of pesticides; PCBs and hydrocarbon on selected organisms;<br>**Activity**<br>**1.BioaccumulationStudy** -Expose a group of organisms (e.g., mussels, fish) to a known concentration of a contaminant over time<br>**2.** Study of Geoaccumulation Index<br>**3.** Study of Pollution Load Index | 4 | 4 |
| | 3.3 | Drugs in aquaculture and fish health management: E.O.,USEPA,ANZECC, FDA and ISO standards of levels of drugs. | 4 | 4,6 |

| | | | | |
|---|---|---|---|---|
| | 3.4 | Pharmacological studies: kinetics and dynamics, detoxification. | 3 | 4,6 |
| | **Radiation Toxicology** | | | **15 hours** |
| 4 | 4.1 | Radiation ecology: Definition, Natural and anthropogenic radiation;<br>Types of radiation and their sources. | 4 | 5 |
| | 4.2 | Radionuclide ecology- distribution of radionuclide in different ecosystems.<br>Dynamics of radionuclides in food chain.<br>Identification of radionuclide sensitive organism – external exposure, internal exposure and risk factors. | 5 | 5 |
| | 4.3 | Environment Impact of radiotoxicity: On phytoplankton, zooplankton, microalgae, benthic microorganism, molluscs, crustaceans and fish.<br>Safety measures for human health. | 3 | 5 |
| | 4.4 | Measurement of radioactivity: counting systems, radiation spectrometry, liquid scintillation counter. | 3 | 5 |
| **Module 5: Teacher Specific Content** | | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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# Mahatma Gandhi University

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fisheries Oceanography** | | | | | |
| **Type of Course** | **DCE** | | | | | |
| **Course Code** | **MG7DCEAQC400** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | Fisheries oceanography is the study of oceanic processes that affect marine ecosystems and the relationship of these ecosystems to the abundance, distribution, and availability of fishery species. A knowledge on fisheries oceanography is needed to improve fisheries resource management. | | | | | |
| **Semester** | 7 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | - | - | | 60 |
| **Pre-requisites, if any** | Students should have a basic knowledge about marine life and organisms. | | | | | |



**COURSE OUTCOMES (CO)**



| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Clear knowledge ondifferent oceanographic processes and marine ecosystem. | U | 1 |
| 2 | In depth knowledge of the community interactions at specific aquatic ecosystems. | U | 1 |
| 3 | Recognize the oceanographic and ecological processes that affect fishery abundance and distribution. | An | 1,2 |
| 4 | Use and apply various sampling devices for marine biological studies. | A | 2 |
| 5 | Application-level knowledge on fisheries oceanography | A | 2 |
| 6 | Collect, analyze, interpret and communicate marine scientific data. | A, S | 2 |

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **Introduction to Marine Environment** | | | **10 Hrs** | |
| 1 | 1.1 | History of marine biological investigations in India and major expeditions. | 3 | 1 |
| | 1.2 | Salient features of world oceans.Oceanographic features of Arabian Sea, Bay of Bengal and Andaman Sea. | 3 | 1,2,3 |
| | 1.3 | Movements of Ocean Water<br>Physico-chemical features of Marine environment- tides, currents, waves, upwelling and monsoon cycles, Mud banks. | 4 | 1,2,3 |
| 2 | **Composition and Properties of Sea water** | | **13 Hrs** | |
| | 2.1 | Elemental composition of water<br>Estimation of Primary Productivity<br>**Activity**:<br>1. Analysis of physico-chemical parameters of sea water.<br>2. Chlorophyll Estimation | 5 | 1 |
| | 2.2 | Physical parameters of sea- tides, waves, light, colour, temperature, currents, density & pressure.<br>Chemical parameters of sea- salinity, dissolved oxygen, pH and nutrients.<br>Oceanographic Equipments.<br>**Activity**: Theory and operation of equipments used for sampling water, sediment, plankton and benthos. | 8 | 1,4,5 |
| 3 | **Marine Ecosystem** | | **19 Hours** | |
| | 3.1 | General characteristics of the marine environment.<br>Zonation of sea.<br>Deep Ocean Topographic features – Continental shelf, continental slope, continental rise, oceanic ridges, trenches, sea mounts, guyots, plateaus, submarine canyons. | 6 | 1,2 |
| | 3.2 | Biological divisions of the sea.<br>Zonation and adaptations – intertidal, rocky, sandy and muddy shore- associated fauna and their adaptations.<br>Deep sea adaptations.<br>Pelagic and Benthic adaptations of the ocean community. | 8 | 1,2 |
| | 3.3 | Population of the oceans - phytoplankton, zooplankton, benthos and nekton. Marine food chains and food webs. | 5 | 1,2,6 |

| | | | | |
|---|---|---|---|---|
| | | **Activity:**<br>1. Methods of collection, analysis and preservation of phytoplankton, zooplankton and Benthos.<br>2. Identification of major zooplanktons, phytoplankton and benthic organisms.<br>3. Chlorophyll Estimation | | |
| 4 | **Fisheries Hydrography , Fish Finding Devices and Fisheries Forecasts** | | **18 Hours** | |
| | 4.1 | Fishery hydrography - Influence of fishery independent factors - El Nino Southern Oscillation (ENSO). | 4 | 3 |
| | 4.2 | Upwelling and fisheries - climate change and fisheries. Oceanography in relation to fisheries. | 4 | 5,6 |
| | 4.3 | Introductory information on echo sounder, Sonar, Netsonde, Global positioning Systems, Remote Sensing, Potential Fishing Zones. Application of Geographic Information System (GIS) in fisheries. | 7 | 5 |
| | 4.4 | Code of conduct of responsible fishing-Turtle Exclusion Devices (TED)-By-catch Reduction Devices (BRD). | 3 | 5 |
| 5 | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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2. Klaff, J. *Limnology: Inland Water Ecosystems*.
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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Aquaculture Engineering** | | | | | |
| **Type of Course** | **DCE** | | | | | |
| **Course Code** | **MG7DCEAQC401** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | Aquaculture Engineering focuses on the design, construction and management of system for cultivating aquatic organisms. This interdisciplinary filed combine element of civil, mechanical and environmental engineering to address the unique challenges of fish and shellfish farming. Topics covered include water quality management, system design, aquaponics, and sustainable practices to optimize production while minimizing environmental impact. Students learn to apply engineering principles to create efficient and environmentally sound aquaculture systems fostering the responsible growth of the aquaculture industry. | | | | | |
| **Semester** | 7 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | | | | 60 |
| **Pre-requisites, if any** | Strong foundation in basic sciences, provide the fundamental knowledge necessary for understanding the biological and physical aspects of aquaculture systems. | | | | | |



**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Understand technical components of farm designing,different components of aquafarms – peripheral dikes, secondary dikes, feeder canals, sluice | U, An | 1, 2 |

| | | | |
|---|---|---|---|
| | gate and monks.Recent trends in aquaculture engineering | | |
| 2 | Apply the planning process, site selection and evaluation, design, components and construction of freshwater and brackish water farms (tanks, ponds, cages and hatcheries) and project formulation and layout. | A | 1,2 |
| 3 | Analyze pipeline, water flow and head loss, pumps-different types;understand and develop equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection. | U, An | 1, 2, 4 |
| 4 | Develop skills in design and fabrication of aerators, compressors, blowers, paddle wheel aerators, and oxygen injection systems.Design recirculation and water use systems Definition, components and design. | A, C | 1, 2,6,10 |
| 5 | Construct different types of feeding equipment, feed control systems, dynamic feeding systems, and instruments for measuring water quality. | C | 1,6,8 |
| 6 | Address the environmental impact of aquaculture operations, includes strategies for minimizing negative effects on ecosystems and surrounding environments. | An, E | 6, 7, 10 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |



## COURSE CONTENT

**Content for Classroom transaction (Units)**



| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Farm Engineering and Aquafarm Facilities** | **15 Hours** | | |
| 1 | 1.1 | Criteria for the selection of site for aquaculture - Surveying – chain survey, plane table survey, leveling. Calculation of earthwork for the construction of ponds. Types of soil, soil sampling methods, prevention of erosion.<br>**Activity-**<br>1.Survey for aquaculture farm construction<br>2.Categorise soil according to their size | 4 | 1, 2 |

| | | | | |
|---|---|---|---|---|
| | | 3. Determination of organic carbon in pond soil and Determination of soil pH<br>4. Grain Size analysis of soil<br>5. Calculation of lime requirement of soil<br>6. Contour Mapping, Chain and Compass Survey | | |
| | 1.2 | Recent trends in aquaculture engineering | 1 | 1 |
| | 1.3 | Design of freshwater and brackish water farms.<br>Different components of aquafarms – peripheral dikes, secondary dikes, feeder canals, sluice gate and monks. | 4 | 1,2 |
| | 1.4 | Various farm equipment. Pumps in aquaculture, different type of pumps. | **3** | 3 |
| | 1.5 | Pipe line, water flow and head loss, pumps-different types<br>**Activity** – identify different types of pumps used in Aquaculture. | **3** | 3 |
| | **Hatchery facilities, Aeration and Oxygenation** | | **15 Hours** | |
| 2 | 2.1 | Components and design of shrimp hatcheries – various components and infrastructure facilities required | 3 | 1, 2 |
| | 2.2 | Equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection<br>Aeration of pond water and different types of Aerators | 3 | 3 |
| | 2.3 | Recirculation and water use systems, definition, components and design. | 4 | 1, 2, 4 |
| | 2.4 | Various hatchery equipment including aeration devices and pumps, design and fabrication of aerators,compressors, blowers, paddle wheel aerators, oxygen injection system<br>**Activity**<br>1.Construct and design Recirculatory system<br>2. Determination of pump efficiency | 5 | 3, 4, |
| | **Feeding System and Instrumentation** | | **15 Hours** | |
| | 3.1 | Different types of feeding equipment | 5 | 5 |

| | | | | |
|---|---|---|---|---|
| 3 | 3.2 | Feed control systems, dynamic feeding systems | 5 | 5 |
| | 3.3 | Instruments for measuring water quality<br>**Activity-**Water quality analysis; Construct feeding equipment | 5 | 5 |
| | **Environmental Monitoring and Impact Assessment** | | **15 Hours** | |
| 4 | 4.1 | Introduction- Definition, history, aim, principles, concept, and scope. | 2 | 6 |
| | 4.2 | Baseline data collection, methods and steps. | 3 | 6 |
| | 4.3 | Impact assessment and impact evaluation -EIA processes, stages, EIA statement environment management plan. National Policy on EIA and regulatory framework<br>Activity- Impact Assessment Study on near canals or estuaries | 5 | 6 |
| | 4.4 | Effluent monitoring, Sewage disposal and treatment, | 5 | 3, 6 |
| **Module 5: Teacher Specific Content** | | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

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**SUGGESTED READINGS:**


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6. Bhari, B., & Visvanathan, C. (2018). *Sustainable aquaculture: Socio-economic and environmental assessment*. In *Sustainable Aquaculture*, 63-93.

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Deep Sea Fisheries, GIS and Remote Sensing** | | | | | |
| **Type of Course** | **DSE** | | | | | |
| **Course Code** | **MG7DCEAQC402** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | An Hitherto underexploited realm of the Marine Environment, the deep sea offers a cornucopia of fascinating animals and which if properly exploited has scope towards contributing to food security. GIS and Remote Sensing offers cutting edge technology to gain understanding of the Aquatic resources without actual physical contact. They provide an important tool for planning marine resources exploitation strategies. | | | | | |
| **Semester** | 7 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 4 | | | | 60 |
| **Pre-requisites, if any** | Students should possess knowledge regarding of marine environment and resources. | | | | | |

**Course Outcome**

| CO No. | Expected Course Outcome | Learning Domains * | PO No |
|---|---|---|---|
| 1 | Remember marine realms | R | 4,10 |
| 2 | Analyze different techniques for gaining remote information on marine exploited resources. | A | 1 |
| 3 | Comprehend the need for remotely locating resources, for their judicious exploitation | An | 2 |
| 4 | Compare different methods of remote sensing | A | 1 |
| 5 | Analyse the role of GIS and Remote sensing in marine fisheries and Aquaculture | An | 3 |
| 6. | Apply the knowledge relating to GIS and Remote Sensing through mobile applications and softwares | **A** | **3** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Deep Sea Fishiery, Deep Sea Fishing Gear and Accessories** | **15 Hrs** | | |
| 1 | 1.1 | Zonation of sea – a brief description<br>Important groups and families of deep sea fishes of Indian EEZ – Oceanic Tunas, Tuna like fishes and Oceanic Squids, Deep sea Shrimps etc.<br>Adaptations of Deep Sea Fishes | 3 | 1 |
| | 1.2 | UNCLOS – Law of the sea , Baseline Territorial waters, Contiguous Zones, EEZ and high seas<br>National Deep Sea Fishing Policy | 2 | 1 |
| | 1.3 | Tuna Long Lining , Gill Netting, Squid Jigging and other Deep sea Fishing Methods. | 3 | 2 |
| | 1.4 | Deck Equipments in Deep Sea Fishing Vessels.<br>**Activity:**Visit to deep sea fishing vessels to study the layout, manpower, facilities for deep-sea navigation and fishing, instruments and fleet management. Study on deck equipments in deep sea fishing vessels.<br>Mother Boat Concept and Factory Vessels in Deep Sea Fishing. | 4 | 2 |
| | 1.5 | **Weather and warning:** Wind, Wave, Current, Cyclones, Squally weathers, Doldrums, Weather forecasting and weather prediction at sea – Weather equipment and storm signals. | 3 | 2 |
| | **Acoustic and Electronic Equipments** | **15 Hrs** | | |
| 2 | 2.1 | Basics of Sound in water, Ultrasonic sound and its characters<br>Automatic Identification System (AIS) | 3 | 3 |
| | 2.2 | Acoustic Equipments used in Fishing, Major Components and Types of Echo Sounder and SONAR | 3 | 3 |
| | 2.3 | Instruments used for evaluation of underwater Gear Performance- Acoustic Trawl Monitoring System | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | 2.4 | Electronic Equipments in Fishing Vessels- GPS, Vessel Monitoring System (VMS), | 3 | 3 |
| | 2.5 | Navigational Equipments- RADAR, Autopilot and Chart Plotter<br><br>**Activity**: Familiarisation with Acoustic Equipments | 3 | 3 |
| | **Remote Sensing** | **15 Hrs** | | |
| 3 | 3.1 | **1.** Electromagnetic Spectrum, Radiation Laws, Spectral Reflectance of Earth Materials and Vegetation. | 3 | 4 |
| | 3.2 | Classification of Remote Sensing based on source, Active and Passive Remote Sensing | 2 | 4 |
| | 3.3 | Satellite Remote Sensing- Platforms and Sensors, Satellite Systems , Indian Remote Sensing Programme.<br><br>**Activity**: Study of satellite information, interpretation of satellite pictures for resource management, case studies on remote sensing and GIS applications. | 5 | 4 |
| | 3.4 | Application of Remote Sensing in Fisheries and Aquaculture- Application in Fisheries Management, Habitat Mapping, Water Quality Monitoring, Fisheries Compliance and Enforcement. | 5 | 4 |
| | **Geographic Information System (GIS)** | **15 Hrs** | | |
| 4 | 4.1 | Introduction to GIS. Differences between GIS and conventional cartography. | 3 | 5 |
| | 4.2 | Maps, Map Projections, Types of Map Projections and Map Analysis. | 4 | 5 |
| | 4.3 | Standard GIS software, Data Types- Spatial and Non Spatial Data, Measurement Scales | 3 | 5 |
| | 4.4 | SST,Ocean Colour Monitoring, PFZ- Basics and Application ,INCOIS- Data dissemination<br><br>**Activity:** Study of Ocean colour Maps | 3 | 5 |
| | 4.5 | Application of GIS in Fisheries and Aquaculture. | 2 | 5 |
| **Module 5: Teacher Specific Content** | | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 30 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 2=20 Marks<br>Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (2 out of 4) 2 X 10 = 20 Marks<br>• Total – 70 Marks |

## REFERENCES


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5. Pillay, T. V. R. (1990). *Aquaculture: Principles and practices*. Fishing News Books.
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7. Mishra, R., & Dora, K. C. (2015). *Text Book on Aquaculture Engineering*. Narendra Publishing House.
8. Garg, S. K. (2018). *Water supply Engineering*.


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4. Wheaton, F. W. (1993). *Aquacultural engineering*. Krieger Publishing Company.
5. Phillips, M. J., Enyuan, F., Gavine, F., Hooi, T. K., Kutty, M. N., Lopez, N. A., ... & Yokoyama, H. (2009). *Review of environmental impact assessment and monitoring in aquaculture in Asia-Pacific*.
6. Bhari, B., & Visvanathan, C. (2018). *Sustainable aquaculture: Socio-economic and environmental assessment*. In *Sustainable Aquaculture*, 63-93.

# SEMESTER 8

| | | | | | | |
|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Research Methodology and Biostatistics** | | | | | |
| **Type of Course** | **DCC** | | | | | |
| **Course Code** | **MG8DCCAQC400** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | Research is a scientific and systematic search for pertinent information. It is a way of systematically solving a research problem. Students will get familiarized with important steps needed for undertaking a research study. It will give an idea about research process starting from identifying a problem to writing a research report and publication. One can enhance and broaden their knowledge in data management, bio statistical analysis, computer applications, and result representations. | | | | | |
| **Semester** | **8** | **Credits** | | | **4** | **Total Hours** |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should have a basic knowledge in research and computer application. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains | PO No |
|---|---|---|---|
| 1 | Explore the significance and function of research and outline the essential steps required for the execution of a research study. | U | 1 |
| 2 | Gain understanding in research design and the methodologies involved in sample collection, data gathering and report writing. | U | 1 |
| 3 | Design and implement research project. | A,C | 1, 2 |
| 4 | Importance of measures that can be used to summarize the data sets. | U | 2 |
| 5 | Understanding, learning, analyzing of descriptive and inferential statistics. | U,A,An | 2 |
| 6 | Awareness and improved comprehension on computer based data presentation and its application. | E,S,C | 1,2 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**



| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | **Research Methodology and Research Design** | | **15 hours** | |
| 1 | 1.1 | The concept of research, characteristics of good research, Application of Research, Meaning and sources of Research problem, characteristics of good Research problem, Research process, outcomes, application of Research, Meaning and types of Research hypothesis, Importance of Review of Literature, Organizing the Review of Literature. | 3 | 1 |
| | 1.2 | Different types of research - descriptive, analytical, applied, fundamental, quantitative, qualitative, empirical and conceptual. | 2 | 1 |

| | | | | |
|---|---|---|---|---|
| | 1.3 | Research process, Different steps in Research process- Flow Chart<br><br>Research Design : Meaning, need, types of research design – Exploratory, Descriptive, Casual research Design, Components of research design, and Features of good Research design. Experiments, surveys and case study Research design.<br><br>Interpretation – Meaning , Techniques of Interpretation | 5 | 2,3 |
| | 1.4 | Research Report : Types of reports; (technical and popular), Mechanics in report writing, Layout of report<br><br>Research report and its structure, journal articles – Components of journal article. Explanation of various components. Structure of an abstract and keywords. | 5 | 1,2,3 |
| | **Introduction To Biostatistics 15 hours** | | | |
| 2 | 2.1 | Origin, definition, applications of biostatistics, Criteria of selecting sampling procedure, sampling methods- sampling frame, sample, characteristics of good sample, simple random sampling, Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. purposive sampling, convenience sampling, | 3 | 4,5 |
| | 2.2 | Data Collection and Analysis- Classification and Tabulation. Diagrammatic representation of Data - graphs and charts – Histograms, Pie Charts, frequency polygon and frequency curves, Frequency distribution<br><br>Types of data- Primary data & secondary data. | 3 | 4,5 |
| | 2.3 | Central Measures of tendency- Mean, Median Mode (Merits and Demerits)<br><br>Measures of dispersion- Range, Quartile Deviation, Mean Deviation, Standard Deviation, Standard error. (Merits & demerits). | 3 | 4,5 |
| | 2.4 | Regression, correlation, Skewness & kurtosis, Testing of hypothesis-Parametric & non-parametric test (Theory in brief)<br><br>Chi Square Test. | 3 | 4,5 |
| | 2.5 | Probability distributions – Normal, Binomial and Poisson Distribution. | 3 | 4 |
| **Application of AI, Research Ethics, Software Tools for Research 15 hours** | | | | |

| | | | | |
|---|---|---|---|---|
| 3 | 3.1 | Definition and application of AI in aquaculture, operating systems, AI software and its characteristics; Advantages of AI. Computer based software SPSS, FISAT. R program: basics- Application of R program in fisheries. | 5 | 6 |
| | 3.2 | Ethics in Research - Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. | 5 | 1,2 |
| | 3.3 | ICT Tools for Research- Role of computers in research, methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism | 5 | 6 |
| 4 | **Practicals** | **30 hours** | | |
| | 4.1 | Preparation of tables and graphs from the given data | 5 | 2 |
| | 4.2 | Calculation of Measures of Central Tendency, Measures of Dispersion , Correlation and Regression. | 5 | 2 |
| | 4.3 | Testing of Hypothesis, Chi Square, Probability distributions | 5 | 2 |
| | 4.4 | Introduction to SPSS and R program in fisheries. | 5 | 6 |
| | 4.5 | Introduction to Reference Management Softwares and Research Softwares | 5 | 6 |
| | 4.6 | Preparation of a Research Paper | 5 | 6 |
| 5 | **Teacher Specific Content** | | | |



| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks |

| | |
|---|---|
| | • Total – 50 Marks<br>**Practicals**<br>• Practical Record = 10 Marks<br>• Preparation of Graphs in MS-Excel from the given Data- 5 Marks<br>• Calculation of Mean/Media/Mode/Any other Measures of Central Tendency from the data - 5 Marks<br>• Calculation of Measures of Dispersion from the data - 5 Marks<br>• Problems relating to Testing of Hypothesis/Chi Square/ Probability distribution- 5 Marks<br>• Use of Reference Management/Research Softwares – 5 Marks<br>• Total – 35 Marks |

## REFERENCES


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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Fisheries Marketing and Trade** | | | | | |
| **Type of Course** | **DCC** | | | | | |
| **Course Code** | **MG8DCCAQC401** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | With the expansion in aquaculture and seafood industry, marketing become an inevitable area of study. This course in marketing and trade covers a range of topics related to understanding consumer behavior, creating effective marketing strategies, and navigating the complexities of international trade. This course equip the students with the knowledge and skills needed to navigate the dynamic and interconnected world of business, whether in the context of local marketing efforts or global trade initiatives. | | | | | |
| **Semester** | 8 | Credits | | | 4 | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess basic knowledge on trade, export & import | | | | | |



## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domain | PO No |
|---|---|---|---|
| 1 | Identifies the basic characteristics of market and marketing. | U, I | 1 |
| 2 | Analyze the different parameters for developing and introducing a new product into a market. | An | 1,2 |

| | | | |
|---|---|---|---|
| 3 | Explain how the product is priced and distributed. | An, A | 2 |
| 4 | Interpret the behavior consumer | S,U, An | 1, 8 |
| 5 | Explain the different agencies and certification related to export & import of fishes | K | 1,2 |
| 6 | Creating knowledge on the current market status of fisheries | A, An | 1 |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| | | **Introduction to Marketing** | **15 Hrs** | |
| 1 | 1.1 | Marketing- meaning and definition.<br>Objectives of marketing. Functions of marketing.<br>Difference between Marketing and selling. Importance of marketing. | 4 | 1 |
| | 1.2 | Marketing mix- product, price, promotion, place. Factors effecting marketing mix.. | 3 | 1 |
| | 1.3 | Market segmentation. Methods of market segmentation (Geographic, Demographic, Psychographic, Behavioral).<br>Targeting- Steps -Targeting strategies (Undifferentiated, Differentiated, Concentrated, Micromarketing).<br>Market positioning concepts and strategy. | 4 | 1 |
| | 1.4 | Consumer buying behaviorand factors influencing it. Demand and Market forecasting.<br>Marketing Research. Uses of marketing research and Information system | 4 | 1 |
| **Product Planning and Development** | | | **16 Hrs** | |
| | 2.1 | Definition of products, goods and services. Classification of products- (a brief of Consumer and Business products). | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| | 2.2 | New product development- Importancestrategy, stages in development process. | **3** | **2** |
| | 2.3 | Trademark, Brand- branding meaning and role, Brand equity | 2 | 2 |
| | 2.4 | Pricing strategies- cost based pricing, demand-based pricing, competition-based pricing. Price elasticities.<br>Price determination of fish and fishery products. | 3 | 3 |
| | 2.5 | Logistics and supply chain.<br>Retailing, Wholesaling, Physical distribution, and Personal Selling. | 3 | 3 |
| | 2.6 | Channels of distribution, Classification of channels. Factors governing the choice of channels of distribution. | 3 | 3 |
| | | **Seafood Trade** | **14 Hrs** | |
| 3 | 3.1 | A brief on international trade- history of GATT & WTO. Different forms of international trade (Export/import, Subsidiaries, Joint ventures, Franchises). Factors influencing international consumer behaviour. | 3 | 4 |
| | 3.2 | Planning and preparations for export/ import operations.<br>Selection of products and markets for export and Import.<br>Registration process- A general registration process for importing and exporting products | 3 | 4,5 |
| | 3.3 | Role of agencies in marketing and trade of fish & fishery products- MPEDA, EIC, DGFT-Directorate General of Foreign Trade,Catch certification, Farm traceability, Green certification etc<br>Free trade agreements and HS code (Harmonized System) for fish products. | 6 | 5,6 |
| | 3.4 | Different marketing practices in fisheries<br>E marketing- scope, concerns and importance<br>Future aspects for diversification of aquatic organisms in export market | 2 | 6 |

| | | | | |
|---|---|---|---|---|
| **Practical** | | | | 30 Hrs |
| | 1 | Select an organization related to fisheries, observe the operation, and interview an administrator and some customers to identify what is being exchanged and whether the unit is product – sales or market oriented | 5 | 1 |
| | 2 | Report on export marketing activities in a seafood processing plant in you locality. Consider such topics as the following: What products are exported? How many jobs are created by export marketing? What is the dollar value of exports? How does the exporting business impact the society? | 5 | 2 |
| | 3 | Interview a marketing manager and prepare a report on consumer decision making and buying behaviour of customers. | 5 | 3 |
| | 4 | Prepare a report after analyzing any one of the below topics after conducting a survey.<br>- If a new product idea is attractive to potential customers<br>- If the intended message in an advertisement is being communicated effectively<br>- Gauge the effect of price change would have on demand of a brand in fisheries<br>How customers feel about an organization and its products | 10 | 2 |
| | 5 | Visit a seafood processing plant and prepare the below reports.<br>-Export/ Import of Seafood and other aquatic products.<br>-Import procedures for live shrimp/ fish broodstock and larvae. | 5 | 3 |
| **5** | **Teacher Specific Content** | | | |

| | |
|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) |

| | |
|---|---|
| | 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>Practical Report = 5 Marks<br>Evaluation of Report on export marketing activities in a seafood processing plant - 10 Marks<br>Evaluation of Report on Procedures involved in Export/Import of seafood/other aquatic products/ live shrimp/ fish broodstock and larva – 10 Marks<br>Evaluation/Viva on a Report on Interviewing a Marketing Manager on consumer decision making and buying behavior of customers- 10<br>Total – 35 Marks |

# REFERENCES


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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Sustainable Aquaculture Policy and Planning** | | | | | |
| **Type of Course** | **DCE** | | | | | |
| **Course Code** | **MG8DCEAQC400** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | Any human activity interfering with the natural ecosystems like agriculture or aquaculture need to be sustainable in the long run. Unchecked aquaculture activities tend to degrade the environment, if not properly monitored. This course introduces the student to sustainability issues and influences of climate change on aquaculture practices. It also discusses various strategies to be adopted for attaining sustainability and also familiarizes the student to the guiding principles of sustainable aquaculture. | | | | | |
| **Semester** | **8** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess a basic knowledge about the different aquaculture practices and their impact on the surroundings and Environment. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Analyse the environmental impact of Aquaculture and understand the conflict between Aquaculture and other farming systems | **An** | **1,2** |

| | | | |
|---|---|---|---|
| 2 | Understand the climate change impact brought about by Aquaculture activities | **U** | **1,2** |
| 3 | Apply measures to reduce energy use and emission of greenhouse gases | **A** | **1,9** |
| 4 | Understand the concept of sustainability in aquaculture | **U** | **1,10** |
| 5 | Understand the role and importance of certifying bodies in Aquaculture | **U** | **1,2,9,** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Sustainability issues in Aquaculture** | | **15 Hrs** | |
| | 1.1 | Environmental and Socioeconomic issues in Aquaculture | **3** | **1** |
| | 1.2 | Introduction and escapement of exotic species, contamination of indigenous gene pool, overexploitation of wild stocks. | **3** | **1** |
| | 1.3 | Salinisation of soil and water ; Environmental impact of Mangrove deforestation | **3** | **1** |
| | 1.4 | Environmental impact assessment,<br>Ecosystem approach to Aquaculture | **3** | **1** |
| | 1.5 | Conflict over water and land use,<br>Conflict of interest between aquafarming and fishermen, aquaculture and other enterprises, social issues, antidumping duties. | **3** | **1** |
| **2** | **Climate Change impact** | | **15 Hrs** | |
| | 2.1 | Weather elements of concern in aquaculture | **3** | **2** |
| | 2.2 | Green house gases, Global warming and their impact | **3** | **2** |
| | 2.3 | Carbon Sequestration in Aquaculture | **3** | **2** |

| | | | | |
|---|---|---|---|---|
| | 2.4 | Microplastics in Aquaculture | **3** | **2** |
| | 2.5 | Measures and tools to reduce energy use and greenhouse gas emissions in Aquaculture. | **3** | **3** |
| **3** | **Strategies for sustainable aquaculture and guiding principles for sustainable aquaculture** | | **15 Hrs** | |
| | 3.1 | Concept of sustainability, Food security, Biosecurity, Organic farming, responsible aquaculture, Rotational aquaculture, Bioremediation, Role of biotechnology, Traceability. | **2** | **4** |
| | 3.2 | Energy conservation- Application of renewable energy in Aquaculture; solar energy, wind and tidal energy. | **3** | 4 |
| | 3.3 | Seed certification, Sustainable use of antibiotics, minimal water exchange system. | **3** | 5 |
| | 3.4 | Coastal aquaculture Guidelines source book,<br>FAO Code of conduct for responsible Fisheries<br>Holmenskollen Guidelines for sustainable Aquaculture | **3** | 5 |
| | 3.5 | Best Management practices in aquaculture<br>Coastal regulation zone implication<br>CAA and its role | **2** | 5 |
| | 3.6 | Ecolabelling , organic certification<br>Pollution Control Board and State Water Bodies protection guidelines. | **2** | **5** |
| **4** | **Practicals** | | | |
| | 4.1 | Visit to aquafarms to collect data on management of used water | **3** | **1** |
| | 4.2 | Economic evaluation of aquaculture practices | **3** | **1** |
| | 4.3 | Case studies on environmental issues of different types of farms | **3** | **1** |
| | 4.4 | Survey on environmental impact of aquaculture farms | **3** | **1** |

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|---|---|---|---|---|
| | 4.5 | Application of GIS and remote sensing on detecting pollution. | **3** | **2** |
| **5** | **Teacher Specific Content** | | | |

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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>1. Presentation of Report/viva on management of used water in aquaculture farms- 7.5 Marks<br>2.Economic Evaluation of any type of Aquaculture Practices- 7.5 Marks<br>3.Presentation of Report/ Viva on case studies of environmental issues of different types of farms- 7.5 Marks<br>4. Presentation of Report on Survey on environmental impact of aquaculture farms – 7.5 Marks<br>5. Principle and Procedure of Application of GIS and remote sensing on detecting pollution – 5 Marks<br>Total – 35 Marks |

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Aquaculture Tourism** | | | | | |
| **Type of Course** | **DCE** | | | | | |
| **Course Code** | **MG8DCEAQC401** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | The Tourism industry, in addition to providing employment, is also considered as a foreign exchange earner. Aquaculture Tourism is the convergence of the science of Aquaculture and the Tourism Industry. This burgeoning niche within the tourism industry involves offering unique insights into the intricate process of seafood production, while fostering environmental stewardship and cultural exchange.. Through an interdisciplinary lens , drawing from diverse filds such as tourism studies, environmental science, economics and sociology, this paper sheds lighton the interplay between aquaculture and tourism. This paper critically evaluates the challenges and opportunities associated with the growth of aquaculture tourism, addressing issues such as carrying capacity, resource management, community engagement, and market demand. By identifying best practices and innovative approaches, we hope to provide insights that can inform policymakers, industry stakeholders, and tourism practitioners seeking to harness the potential of aquaculture tourism for sustainable development. | | | | | |
| **Semester** | **8** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess a basic knowledge about the different aquaculture practices and their impact on the surroundings and Environment. | | | | | |

**COURSE OUTCOMES (CO)**

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Understand the concepts and principles of Aquaculture Tourism | **U** | **1,2** |
| 2 | Analyse Aquatourism product development and its challenges. | **An** | **1,2** |
| 3 | Evaluate Operational safety and Health issues in Aquatourism | **E** | **1,9** |
| 4 | Analyse the Economic and Sociocultural impacts of Aquatourism | **An** | **1,10** |
| 5 | Apply knowledge of policy and regulations to Aquatourism | **A** | **1,2,9,** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

**COURSE CONTENT**

**Content for Classroom transaction (Units)**

| Module | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Aquaculture Tourism – Introduction and Concepts Aquatourism Product Development; Operational and Safety Infrastructure** | | **15 Hrs** | |
| | 1.1 | Aquaculture Tourism- Introduction, Concepts and Principles<br>Emerging Trends in Aquatourism and its potential | **2** | **1** |
| | 1.2 | Components of Aquatourism Industry; offshore and Inland, surface water and underwater, motorized and non motorized, shoreline recreation, Sport Fishing- Marine and Inland | **2** | **1** |
| | 1.3 | Nautical Tourism, Maritime Tourism , Cruise Tourism and its potential in India | **2** | **1** |

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|---|---|---|---|---|
| | 1.4 | Beach based leisure pastimes and its spread; Factors influencing the sector's growth and its expansion | **2** | **1** |
| | 1.5 | Aquatourism Product Development and its challenges; Entrepreneurial characteristics, oppurtunities and challenges in the sector | **3** | **2** |
| | 1.6 | Setting up and operation of Aqua-tourism business, Career oppurtunities; participant's behavior and bearing of it on major impacts and its types (case studies of one surface-water, under-water and beach-based each). | **4** | **2** |
| **2** | **Operational, Safety and Health issues in Aquatourism 15 Hrs** | | | |
| | 2.1 | Operational and safety Infrastructure: jetties, marinas and its economics, impacts of Marinas | **3** | **3** |
| | 2.2 | Risk assessment, Strategies and mitigation; Major safety equipment and gears; Clothing; First aid &<br>CPR. | **3** | 3 |
| | 2.3 | Operation and management of boat-clubs; navigational aids- GPS and its usage, map reading; | **3** | 3 |
| | 2.4 | Legal and regulatory framework for the business; CZMA and its bearing on off-shore business. | **3** | 3 |
| | 2.5 | Major destinations for aquatourism in India; case<br>studies on houseboats of Kerala, water-theme parks and Scuba dive centres. | **3** | 3 |
| **3** | **Aquaspa, Coastal Tourism , Policy and Regulations 15 Hrs** | | | |
| | 3.1 | Aquaspa or Fish pedicures- Origin, Cultural roots and Evolution over time<br>Species of Fishes used- their behavior and natural habitat | **3** | **4** |

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| | | Benefits- Skin exfoliation, Relaxation and potential therapeutic effects on skin conditions<br>Risks and concerns- Spread of infectious diseases | | |
| | 3.2 | Coastal tourism: Beach resorts, restaurants and parks within the coastal zone as per existing rules and regulations. Impact of pollution on coastal resources. | **3** | **4** |
| | 3.3 | Economic Impact: Contribution of aquaculture tourism to local economies. | **3** | **4** |
| | 3.4 | Socio-cultural Implications: Cultural heritage, community involvement, and social aspects of aquaculture tourism. | **3** | **4** |
| | 3.5 | Policy and Regulation: Government policies, regulations, and management practices related to aquaculture tourism.<br>**Activity**<br>1. Site Visits: Field trips to aquaculture facilities and tourism destinations.<br>2. Case Studies: Analyzing successful aquaculture tourism initiatives and learning from challenges faced. | **3** | **5** |
| 4 | **Practicals** | | **30 Hrs** | |
| | Visit an Aquatourism Centre and prepare a detailed report on their activities | | **5** | **1,2** |
| | Design an itinerary for a visit to an Aquatourism Centre; prepare a cost and budget package for the same. | | **5** | **2** |
| | Study of Equipments used in Aquaculture (Nets, Feeding tools and Water Testing Kits)<br>Study of Safety Equipments and first aid kits | | **5** | **2** |
| | Study of Materials for Marketing and Educational activities (Brochures, Displays, Social Media Tools) | | **5** | **4** |
| | Training on using a customer feedback form to improve service quality | | **5** | **4** |
| | Prepare a sustainability action plan for a tourism project | | **5** | **5** |

| 5 | Teacher Specific Module |
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| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Tour Report to an Aquatourism Centre – 10 Marks<br>• Preparation of Tourism Brochure/ Customer Feedback form = 5 Marks<br>• Identification and Comments on Safety Equipments and fist aid kits – 10 Marks<br>• Presentation of a sustainability action plan for a Tourism Project – 5 Marks<br>• Viva = 5 Marks<br>• Total – 35 Marks |



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# Mahatma Gandhi University

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|---|---|---|---|---|---|---|
| **Programme** | **BSc (Hons) Aquaculture** | | | | | |
| **Course Name** | **Artificial Intelligence in Aquaculture** | | | | | |
| **Type of Course** | **DCE** | | | | | |
| **Course Code** | **MG8DCEAQC402** | | | | | |
| **Course Level** | **400** | | | | | |
| **Course Summary** | The course "Application of AI Tools in Aquaculture and Fisheries Management" provides an in-depth exploration of how artificial intelligence (AI) technologies are revolutionizing the practices of aquaculture and fisheries management. The course begins with an introduction to AI and its significance in enhancing efficiency, sustainability, and productivity in aquaculture and fisheries management. Students delve into traditional methods and the limitations they pose, paving the way for understanding how AI tools offer innovative solutions.Through modules focused on AI applications in aquaculture, students learn about the implementation of AI-driven sensors, data analytics, and machine learning algorithms for monitoring and optimizing aquaculture environments, automating feeding systems, and detecting diseases early. Challenges and opportunities associated with implementing AI in aquaculture and fisheries management are thoroughly examined, including technical, socio-economic, and ethical considerations. Through case studies, students analyze real-world applications of AI in these industries, understanding both the successes and limitations of AI adoption. | | | | | | |
| **Semester** | **8** | Credits | | | **4** | Total Hours |
| **Course Details** | Learning Approach | Lecture | Tutorial | Practical | Others | |
| | | 3 | | 1 | | 75 |
| **Pre-requisites, if any** | Students should possess knowledge regarding basics of Artificial Intelligence and Automation. | | | | | |

## COURSE OUTCOMES (CO)

| CO No. | Expected Course Outcome | Learning Domains* | PO No |
|---|---|---|---|
| 1 | Creating knowledge on the use of AI tools in aquaculture and fisheries | **U** | **1,2** |
| 2 | Developing skill to use various AI tools in aquaculture and fisheries. | **S** | **1,2** |
| 3 | Utilize AI tools for the betterment of aquaculture and fisheries sector | **An** | **1,2** |
| 4 | Formulate methods for the better use of AI tools in aquaculture and fisheries | **C** | **1,2** |
| 5 | Evaluate the basic concepts of AI tools for the development of aquaculture and fisheries | **E** | **1,2** |
| 6 | Acquire in depth knowledge and field exposure on the use of AI tools for the development of aquaculture and fisheries | **A, S** | **2,10** |
| ***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*** | | | |

## COURSE CONTENT

**Content for Classroom transaction (Units)**

| | Units | Course description | Hrs | CO No. |
|---|---|---|---|---|
| **1** | **Introduction to AI in Aquaculture and Fisheries Management** | | **10 Hours** | |
| | 1.1 | Definition of AI and its significance in aquaculture and fisheries management | **3** | **1** |
| | 1.2 | Overview of traditional methods used in aquaculture and fisheries management | **5** | **1** |
| | 1.3 | AI software and its characteristics; AI in aquaculture, advantages of AI | **2** | **1** |
| **2** | **AI Applications in Aquaculture** | | **9 Hours** | |

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|---|---|---|---|---|
| | 2.1 | Monitoring and optimization of aquaculture environments using AI-driven sensors and data analytics | **5** | **2,3** |
| | 2.2 | Application of machine learning algorithms for predictive modeling of water quality parameters<br>Use of AI for automated feeding systems and precision aquaculture<br>AI-powered disease detection and early warning systems in aquaculture facilities | **4** | **2,3** |
| **3** | **AI Applications in Fisheries Management and Challenges, Oppurtunities and Future Directions in implementing AI in Aquaculture and Fisheries management** | | **26 Hrs** | |
| | 3.1 | Utilization of AI for fish stock assessment and population dynamics modeling | **3** | **2,3** |
| | 3.2 | AI-driven satellite imagery and remote sensing for monitoring fishing activities and detecting illegal fishing | **3** | **2,3** |
| | 3.3 | Implementation of AI algorithms for optimizing fishing fleet management and route planning<br>AI-based decision support systems for sustainable fisheries management and policy development | **5** | **2,3** |
| | 3.4 | Scope for Robotics in aquaculture, ROV, AUV, Drones,<br>ASV. Automation for water quality management and health management in aquaculture, | **6** | **3,4** |
| | 3.5 | Technical challenges such as data integration, model interpretability, and scalability<br>Socio-economic implications of AI adoption in aquaculture and fisheries management. Ethical considerations related to the use of AI in resource management and conservation | **5** | **4,5** |
| | 3.6 | Opportunities for collaboration between academia, industry, and government agencies to address challenges and promote responsible AI adoption | **4** | **6** |

| | | | | |
|---|---|---|---|---|
| | | Exploration of emerging trends and future directions in AI research and development for aquaculture and fisheries management | | |
| **4** | **PRACTICALS** | | **30 Hours** | |
| | 4.1 | Demonstration AI-driven automated feeding system for fish farms. Demonstration Of working of AI powered fish feeding devices | **5** | **4,5** |
| | 4.2 | Compare the effectiveness of AI-driven monitoring with traditional manual monitoring methods. | **5** | **4,5** |
| | 4.3 | Demonstration of AI models to identify common fish diseases based on symptoms and visual cues | **10** | **4,5** |
| | 4.4 | Drones – Types – working ( Demo only)<br>Demonstration the applications of drones in aquaculture – Feeding<br>Prepare a model of a drone | **10** | **4,5** |
| **5** | **Teacher Specific Content** | | | |

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|---|---|
| **Teaching and Learning Approach** | Lecturing with ICT activities<br>Transactions |
| **Assessment Types** | **Mode of Assessment**<br>**A- Continuous Comprehensive Assessment (CCA)**<br>• Theory – 25 Marks<br>• Practical – 15 Marks |
| | **B. Semester End Examination**<br>**Theory**<br>• Very short answer questions /MCQ (10 out of 12) 10 X 1=10 Marks<br>• Short Answer Questions (6 out of 9) 6 X 5 = 30 Marks<br>• Essay (1 out of 3) 1 X 10 = 10 Marks<br>• Total – 50 Marks<br>**Practicals**<br>• Practical /Industrial visits Record/Lab report= 10 Marks<br>• Presentation of Report and viva on any automated or AI driven system in Aquaculture = 10 Marks<br>• Identification of drones/ASV/AUV with principle = 10 Marks |

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| | • Viva = 5Marks<br>• Total – 35 Marks |

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19. Zhang, Y.; Fitch, P.; Thorburn, P.J. Predicting the trend of dissolved oxygen based on the kPCA-RNN model. Water 2020, 12, 585, https://doi.org/10.3390/w12020585.

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**Suggested Reading**

• Balchen, J.G. (Ed), 1986. *Automation and Data Processing in Aquaculture: Proceedings of the IFAC Symposium*, Trondheim, Norway, 18-21 August 1986 (Ifac Symposia Series) 1stEdition

• https://www.eolss.net/Sample-Chapters/C18/E6-43-35-05.pdf

• https://www.sciencedirect.com/science/article/pii/014486099400 002I

• https://pdfs.semanticscholar.org/ae37/7b22085fbb6b975855f5f3 426c2357294be9.pdf

• http://ijsrcseit.com/paper/CSEIT172254.pdf

• Unbehauen, H.D., 2009. *Control Systems, Robotics And Automation*–Volume XIX: Industrial Applications of Control Systems-II. EOLSS Publications.

## PROJECT EVALUATION GUIDELINES

1. All students shall prepare and submit project report as part of the programme. The project has to be undertaken on an individual basis.
2. The general guidelines of the Regulations shall apply for both Internal and External Evaluations of Project Report.
3. The Project shall be done under the supervision and guidance of faculty of the Department.
4. Students shall submit the report in the prescribed format before the commencement of the end semester examination of the eighth semester. Internal assessment shall be based on completion of the project, following the norms prescribed in general guidelines.
5. The area of project shall be related to Aquaculture/Fish and Fishery Biology/ related fields/socially relevant topics related to Aquaculture/Fisheries etc. Topics may also be selected with the help of linkages with industry or policy making bodies.
6. The student shall submit copies of the project report, either printed or typed.. The report may be hard bound or soft bound or spirally bound and the printing can be either double sided or single sided. A softcopy of the report shall also be submitted to the department.
7. The report shall contain the following:

   -Title page with topic, details of the student with register number, supervisor details and month and year of submission.
   -Certificate from Supervising teacher and counter signed by the Head of the Department with department seal.
   -Declaration by the student which shall include plagiarism details also. The relevant guidelines issued by the UGC and the University shall be strictly adhered to.

   -Acknowledgement
   -Contents
   -Preferably 5 chapters with

   **Chapter 1** Introductio to the Topic
   **Chapter 2** Literature Review
   **Chapter 3** Materials and Methods/ Methodology
   **Chapter 4** Results/Relevant Findings
   **Chapter 5** Discussion, Conclusion, Suggestions etc.
   Guidelines regarding chapterisation are not absolute and may be altered according to topic/ presentation convenience.

   -Appendix (Questionnaire/Schedule , Secondary data used for analysis, Statistical calculation details etc)
   -Bibliography (References may be presented in APA style)

8. The student shall do progress presentation and pre-submission presentations, which will be evaluated by the Guide and the Head of the Department. The department shall decide the dates of the progress presentations. The final pre-submission presentation shall be an open presentation with the help of audio-visual aids and shall be evaluated by a Board

of Internal Examiners including the Guide and the Head of the Department, Final submission of the project report shall be based on the suggestions of the open presentation. The End Semester Evaluations shall be done by an external examiner and the Head of the Department/the nominee of the HoD. There shall be a viva voce.

9. It is the responsibility of the student to put in earnest effort into the completion of the project. The consequences of plagiarism beyond permissible level in project work may result in failure of the course, in addition to other consequences.

EVALUATION CRITERIA

**PROJECT EVALUATION**

**Project with 12 Credits (200 marks)**

| | | |
|---|---|---|
| **1. Internal Evaluation (60 marks)** | | |
| i) | Initiative and Independence | 10 Marks |
| ii) | Technical Skill | 10 Marks |
| iii) | Communication Skills | 10 Marks |
| Iv | Professionalism | 10 Marks |
| v) | Presentation | 20 Marks |
| If the student is doing the project in an external Institution, the internal marks may also be obtained from the Project Supervisor | | |
| **2. Final Evaluation (140 Marks)** | | |
| i) | Abstract | 5 Marks |
| ii) | Novelty of the work | 5 Marks |
| iii) | Experimental/Project Design | 25 Marks |
| iv) | Literature Survey | 10 Marks |
| v) | Results and Discussion | 40 Marks |
| vi) | Presentation of the work | 40 Marks |
| vii) | Viva - voce | 15 Marks |

## INTERNSHIP EVALUATION GUIDELINES

1. All students shall undergo summer internship or apprenticeship in a firm, industry or organization or training in labs with faculty and researchers or other higher education institutions (HEIs) or research institutions after completion of the fourth semester.

2. The Department shall approve the institution/organisation where every student is planning for internship. Internal mentors shall be assigned to the students for necessary guidance.

3. The nature of the work shall depend on the type of organisation selected. The area of internship can be fields relating to Fishery/Fish Biology, Aquaculture, Fish Processing or any other areas relevant to the subject. Any area which provides practical insights for the students and improves their employability skills shall be considered.. The internship will be of not less than two weeks duration.

4. The student shall prepare a Daily Work Record and submit the same to the department periodically as decided by the internal mentor. At the end of the Internship tenure, an Internship Report with the outcomes along with the certificate of attendance shall also be submitted.

**EVALUATION SCHEME (Total 50 Marks)**

**1. Internal Evaluation (15 Marks)**

(Internal marks may be obtained from the organization/Institution , where the student is doing internship in the following format.*

**B.Sc. Aquaculture Student Evaluation form for Internship**

**Internship Details**

Student Name:

Date of Evaluation:

Duration of Internship:

Mentor Name:

**Instructions:** Please rate the student's performance based on their abilities, skills and behavior during the Internship.

| | |
|---|---|
| 1. Technical Skills and Problem Solving | : 3 Marks |
| 2.Communication Skills and Collaboration | : 3 Marks |
| 3.Professionalism | : 3 Marks |
| 4.Adaptability | : 3 Marks |
| 5. Overall Performance | : 3 Marks |
| Total (out of 15) | |

**Comments and Recommendations: (**Provide specific comments on the student's strengths, areas for improvement and any additional feedback or recommendation for their future development)

**Mentor Signature: (**Insert Mentor's Signature)

**Date:** (Insert date of Evaluation)

* In case , it is not possible to get an evaluation report from the organization/Institution, where the internship is done, the CCA or Internal Evaluation shall be based on the Daily Work Record and Attendance. It shall be evaluated by the Internal Mentor and Head of the Department.

**2. End Semester Evaluation (35 Marks)**

**1. Internship Report Evaluation – 15 Marks**

**2. Presentation and Viva - 20 Marks**

The evaluation of the report and presentation/viva shall be done by a Board of Internal Examiners as decided in the Department Council or by External Faculty as decided by the University.

## STUDY TOUR

A Study Tour of minimum three days duration is recommended by the Board of Studies , during the third year of the B.Sc. Honours programme. The Tour may be undertaken to public Aquariums, Aquaculture farms, Fish Processing and Aquaculture related enterprises/Industries/ locations or to reputed Government/ Private institutions/organizations related to the subject. The objectives of the study Tour are

**1. Enhancing learning:** Study tours can bring classroom concepts to life by allowing students to see and experience them firsthand. This can lead to a deeper understanding of the material and a stronger memory of what is learned

**2. Developing critical thinking:** Being exposed to new environments and cultures can challenge students to think outside the box and consider different perspectives .

**3. Building practical skills:** Study tours can provide opportunities for students to develop practical skills that may be difficult to learn in a classroom setting, such as communication, teamwork, and problem-solving .

**4.Increasing engagement:** A change of scenery from the traditional classroom can boost student engagement and motivation .

A study tour can be a valuable learning experience that complements classroom instruction and helps students develop a well-rounded understanding of the subject matter.

| PARTICIPANTS- FYUGP WORKSHOP IN AQUACULTURE | | |
|---|---|---|
| (held at St. Albert's College, Ernakulam, Nov 20-24, 2023) | | |
| **Name** | **Designation** | **Institution** |
| Dr.K.J.Abraham | Assistant Professor and Chairman, BOS in Aquaculture; MG University | St. Xavier's College, Vaikom |
| Dr. Bijoy.V.M | Associate Professor , Member BOS (Aquaculture) | St. Albert's College (Autonomous), Ernakulam |
| Dr.Rekha Parthasarathy | Assistant Professor , Member BOS (Aquaculture) | SNM COLLEGE MALIANKARA |
| Sojomon Mathew | Assistant Professor , Member BOS (Aquaculture) | Govt. College Kottayam |
| Dr. P. Shylaja Kumari | Assistant Professor , Member BOS (Aquaculture) | Govt Arts and science college Elanthoor Pathanamthitta |
| Dr SUJATHA S | Assistant Professor , Member BOS (Aquaculture) | Govt College Kottayam |
| Dr SOJA LOUIS | Associate Professor , Member BOS (Aquaculture) | St. Teresa's College (Autonomous) |
| Dr. Suresh Kumar | Professor , Member BOS (Aquaculture) | KUFOS |
| Dr. Arun A.U. | Associateb Professor , Member BOS (Aquaculture) | St. Peter's College, Kolenchery |
| Dr Suja N | Assistant Professor | St Aloysius College, Edathua |
| DR. SHINY K. J. | Associate Professor | Government College Kottayam |
| Blessy V Rajan | Assistant Professor | St Xavier's College, Vaikom |
| Dr.Sarita Ramachandran | Assistant Professor | St.Xavier's College Vaikom |
| Anu Thottappilly | Assistant Professor | Sacred Heart College, Thevara |
| Dr. Eapen Jacob | Assistant Professor | University College, Thiruvananthapuram |

| | | |
|---|---|---|
| Dr. Santu K.S. | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr.Ambily.V | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr Sree Renjima G | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Sharanya Manilal | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Abhitha J Karun | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Sneha R Pai | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr. Bijoy V M | Associate Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr. Bindhi S. Kumar | Govt.Guest Faculty | St. Albert's College (Autonomous), Ernakulam |
| Dr Renjithkumar CR | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Jithu Paul Jacob | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Sayeed Mohammed P K | Assistant professor | St. Albert's College (Autonomous), Ernakulam |
| Dr. Viji C S | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr. Sreerekha R | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Nayana O V | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr. Melby Emmanuel | Assistant professor | St. Albert's College (Autonomous), Ernakulam |
| Junemary Josy | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Dr.Radhika R | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Sivakumar G | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |
| Vishnu R | Assistant Professor | St. Albert's College (Autonomous), Ernakulam |