ALAGAPPA UNIVERSITY

(A State University Established in 1985)
Karaikudi - 630003, Tamil Nadu, India

2017 — Accredited with A+ Grade by NAAC (CGPA : 3.64)

2018 — MHRD Govt. of India; UGC — Graded as Category - 1 & Granted Autonomy

2018 — MHRD — Swachh Campus Rank : 4

2019 — nirf NATIONAL INSTITUTIONAL RANKING FRAMEWORK — Rank : 28

2019 — QS — India Rank : 20, BRICS Rank : 104, Asia Rank : 216

DEPARTMENT OF FISHERIES SCIENCE

M.Sc., FISHERIES SCIENCE

[Choice Based Credit System (CBCS)]

[For the candidates admitted from the academic year 2021 -2022]

DEPARTMENT OF FISHERIES SCIENCE

M.Sc., Fisheries Science

REGULATIONS AND SYLLABUS

[For the candidates admitted from the Academic Year 2021 – 2022 onwards]

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC)

Science Campus, Karaikudi -630003, Tamil Nadu.

The panel of Members-Broad Based Board of Studies

Chairperson

Prof. E. Kannapiran, Professor and Head *i/c*, Department of Fisheries Science, Alagappa University, Karaikudi. Teaching Experience: 23 years, Research Experience: 22 years, Area of Research: Aquatic Microbiology, Coral reef ecosystem, Marine Fouling.

Members

Dr. R. Jayakumar, Principal Scientist - Scientists in charge, Central Marine Fisheries Research Institute, Marine Fisheries P.O., Mandapam Camp - 623520 Professional experience: 25 years, Area of Research: Mariculture, Finfish Breeding and seed production, Fish Health Management.

Dr. T.T. Ajith Kumar, Principal Scientist - Scientists in charge, National Bureau of Fish Genetic Resources, Regional Centre, Cochin. Professional experience: 21 years. Area of Research: Development of hatchery technologies for marine Ornamentals, Aquaculture for conservation and livelihood.

Dr. M. Arumugam, Associate Professor, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai – 608502. Professional Experience: 15 years. Area of Research: Marine Natural Products & Drug Discovery Research.

Dr. A. Gopalakrishnan, Assistant Professor, Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai – 608502. Teaching Experience: 14 years, Research Experience: 13 years. Area of Research: Aquatic Animal Health and Livelihood Security.

Dr. N.M. Prabhu, Assistant Professor, Department of Animal Health and Management, Alagappa University, Karaikudi. Teaching and Resarch Experience: 13 years, Industrial Experience: 9 years. Area of Research: Disease Control and Prevention, Alternative medicine: Sulfated polysaccharides, probiotics, and nanoparticles.

Expert from Industry

Mr. P.K. Senthil Kumar, Manager and Co-ordinator, Poseidon Biotech, No.2,3, PKM cross street, Padasalai road, Mel Ayanampakkam, Chennai - 600 095. Co-ordinator: Society of Aquaculture Professionals. Professional Experience: 27 years.

ALAGAPPA UNIVERSITY

DEPARTMENT OF FISHERIES SCIENCE

Science Campus, Karaikudi -630003, Tamil Nadu.

REGULATIONS AND SYLLABUS

[For the candidates admitted from the Academic Year 2021 – 2022 onwards]

Name of the Department : **Department of Fisheries Science**

Name of the Subject Discipline : **Fisheries Science**

Programme of Level : **M.Sc. Fisheries Science**

Duration for the Course : Full Time (Two Years)

Master of Science in Fisheries Science (M. Sc.)

M.Sc. Fisheries Science is a postgraduate program and duration of the programme is two year that spread over four semesters. The course deals with the study of administration and culture, catching, processing and marketing and conservation of fish and related products. The M.Sc. program can be considered as the interdisciplinary field to the areas of Fisheries Science, Aquaculture, and Industrial Fisheries, Agriculture, Marine Biology, Zoology, Biology, Microbiology, Biotechnology, Management, Economics and Marketing.

1. Programme general objectives

The general objective of the M.Sc. program in Fisheries Science is to develop strong-minded graduates with high-quality skills in the field of Fisheries Science. The curriculum designed to prepare the students in understanding the vital concept of fishery resources, fish taxonomy, identification of fish using molecular tools, modern craft and gears in capture fishery, diversity, biology, genetics, breeding, freshwater, coastal and marine aquaculture and fishery conservation & management. At the end of the program, the student will gain profound knowledge of professional skills in fishery biology and aquaculture as well as well-known with national and international fishery science & technology and equipped with comprehensive knowledge structure. This will help the students to play an active role in research, government or non-government organization, private and corporate sectors.

2. Programme specific objectives

1. To prepare the student with fishery talent and practitioners to develop the nation.
2. To teach the student with a broad understanding of fish and their interactions with different ecosystem.
3. To make a student spirit of modernism and practices in the field of fishery science and capable of independently engaging in fishery techniques, that helps the students to support for improving the socio-economic status of fishermen community.
4. To provide in-depth knowledge and recent to the students in the field of aquaculture that will give confidence to the student for self-employment.
5. To enable the students for preparing various government and private sectors competitive examinations.

3. Programme outcome

On successful completion of the Master of Fisheries Science programme, the students may acquire the following:

- The students will be talented to connect in notable, self-governing, and original research in the field of fishery biology and aquaculture.
- The students are competent enough to setup aquaculture, fish processing and fish by product business.
- Students are able to support fish production, improving the welfare of fishermen, promoting export earnings and providing food security to the country.
- Student would acquire significant knowledge to clear the competitive examinations in the field of fishery science.

4. Eligibility for admission

The students who have passed the UG degree in B.F.Sc./ B.Voc./ B.Sc./ B.Tech. in Fisheries Science/ Aquaculture/ Commercial Aquaculture/ Industrial Aquaculture/ Industrial Fish and Fisheries/ Marine Biology/ Marine Science/ Zoology/ Zoology and Animal Biotechnology/ Biotechnology/ Industrial Fish Processing Technology/ Industrial Fishing Technology/ Fisheries Engineering/ Fisheries Nautical Technology/ Food Technology/ Aquatic Animal Health Management/ /Animal Sciences / Biological Sciences can apply for the M.Sc. Fisheries Science program.

5. Duration of Programme

The programme shall consist of two academic years, divided into four semesters. Each semester consists of 90 working days.

6. M.Sc. Course Curriculum

The curriculum of the M.Sc. program is divided into 4 semesters. It includes the Core subjects with minimum 3-4 credits, optional discipline specific electives and non-major elective theory subjects and practicals. The classroom discussion and seminars cover the major part of the theory paper. There will be practical paper for each subject and at the end of the program the candidates should take a research work on the selected topics in the specialization field or internship. In a nutshell, the course curriculum of the program is designed to carry out the broad research work in the field of Fisheries Sciences. The Core, Discipline Specific Electives, Non-Major Elective courses offered to the M.Sc. candidates in Alagappa University are given in **ANNEXURE - I**.

7. Teaching Methods

The classroom teaching would be through conventional lectures, use of OHP, Power Point presentation, novel innovative teaching ideas like television, smart board, and computer-aided instructions. Periodic field visit to fish landing centers and pre-processing centers to enable the student for gaining the practical experience in fish identification and update industrial scenario. Student seminars would be arranged to improve their communicative skills. The Fishery lab experiments shall be conducted with special efforts to teach scientific knowledge among students. The students shall be trained to handle advanced instrumental facilities and shall be allowed to do experiments independently. The periodic test will be conducted to assess their knowledge. Slow learners would be identified and will be given special attention by remedial coaching. Major and discipline specific electives would be handled by the Department, and the students shall undertake Non-major electives in the second and third semesters offered by other departments.

8. Examinations

The examinations shall be conducted separately for theory and practical's to assess the knowledge acquired during the study. There shall be two systems of examinations viz., internal and external examinations. The internal examinations shall be conducted as Continuous Internal Assessment tests I and II (CIA Test I & II). The internal assessment shall comprise a maximum of 25 marks for each subject. The following procedure shall be followed for awarding internal marks.

8.1. Internal Assessment

8.1.1. Theory paper (Internal Assessment)

Title	Marks
Average marks of two CIA test	10
Attendance	5
Seminar/group discussion/quiz	5
Assignment/field trip report/case study reports	5
Total	**25**

8.1.2. Practical's (Internal Assessment)

Title	Marks
Average marks of two CIA test	10
Attendance	5
Observation note book	10
Total	**25**

8.2. External Examinations

The external examinations of theory and practical shall be conducted for three hours duration for each paper at the end of every semester except IV semester (IV semester is exclusively for Dissertation or internship). The external examinations shall comprise of a maximum of 75 marks for each subject. The candidate failing in any subject will be permitted to appear for each failed subject in the subsequent examination. Practical examinations and demonstration of experiments shall be conducted at first, second, and third semester. At the end of the fourth semester, the project work viva-voce examination will be held based on the dissertation report submitted by the student. Two examiners (one internal and one external) will jointly conduct the viva-voce examination and evaluation.

8.2.1. Scheme of External examination

Question paper pattern (Theory)

- The question paper carries a maximum of 75 marks.
- The question paper consists of three sections, namely Part-A, B, and C.
- **Part-A** consists of 10 questions of 2 marks each (10 x 2 = 20 marks) with no choice. The candidate should answer all the questions.
- **Part-B** consists of 5 either-or choice questions. Each question carries 5 marks (5 x 5=25 marks).
- **Part-C** consists of 5 questions. Each question carries 10 marks. The candidate should answer any three questions (10 x 3 = 30 marks).

Question paper pattern (Practical) (Maximum 75 marks)

Title	Marks
Major Practical	15
Minor Practical	10
Experimental setup	5
Spotters- (5 spotters x 5 marks)	25
Viva-voce	10
Practical Record Note	10
Total	**75**

9. Passing minimum

1. For Internal and External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
2. In the aggregate (External + Internal), the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.
3. Grading shall be based on overall marks obtained (internal + external).

10. Dissertation Work or Internship (Maximum Marks: 200)

Students can choose either Dissertation work or Industrial training as internship. The duration of the Dissertation Work or Internship shall be a minimum of three months in the fourth semester.

a) Plan of work

Dissertation work: The candidate shall undergo Dissertation Work in the final semester. The candidate should prepare a scheme of work for the dissertation and should get approval from the guide. The candidate, after completing the dissertation work, shall be allowed to submit dissertation to the university at the end of the fourth semester. If the candidate is desirous of availing the facility from other universities/laboratory, they will be permitted only after getting approval from the HoD. In such a case, the candidate shall acknowledge the same in their dissertation. The students can take up dissertation work in any of the National/State level Research and Development Institutes/ Laboratories in the country, under the guidance of the experts in the respective institutions/ laboratories.

Internship: The students who have opted Internship, they must undergo industrial training on fish farming, hatchery operation, fish/shrimp processing, fish/shrimp feed production, feed supplement production, fish/shrimp health product development and fish/shrimp health testing services in the reputed organizations to accrue industrial knowledge in the final semester. Student has to find an industry and get approval from the head of the department before going for internship.

The candidate should prepare three copies of the dissertation and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, one copy will be retained by the guide and the student shall hold one copy.

b) No. of copies of the dissertation

The candidate should prepare three copies of the dissertation and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, one copy will be retained by the guide and the student shall hold one copy.

c) Format to be followed for dissertation

The format /certificate for thesis to be followed by the student are given below

- Title page
- Certificate
- Acknowledgment

Content as follows:

Chapter No.	Title	Page No.
1	Introduction	
2	Review of Literature	
3	Materials and Methods	
4	Results	
5	Discussion	
6	Summary and Conclusion	
7	References	

d) Format of the title page

Title of Dissertation

Dissertation submitted in partial fulfillment of the requirement for the degree of Master of Science in Fisheries Science to the Alagappa University, Karaikudi

By

(Student Name)

(Register Number)

University Logo

Department of Fisheries Science

Alagappa University

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC, 2019: QS ASIA Rank-216, QS BRICS Rank-104, QS India Rank-20)

Karaikudi - 630003

(Year)

e) Format of certificate

Certificate

This is to certify that the dissertation entitled _____ submitted in partial fulfilment for the requirement of the Degree of Master of Science in Fisheries Science to the Alagappa University, Karaikudi is a bonafide record of research work done by Mr./Mrs_____ under my supervision and guidance and that no part of the dissertation has been submitted for the award of degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or in full in any scientific journal or magazines.

f) Dissertation evaluation

Title	Mark
Thesis	100
Viva voce (external)	50
Internal	50
Total	**200**

Internship evaluation

Title	Mark
Report	100
Viva voce (external)	50
Internal (two midterm evaluation (25 + 25)	50
Total	**200**

11. Village Extension Programme (VEP)

The Sivaganga and Ramanathapuram districts are most backward districts where a majority of people lives in poverty. The rural mass is economically and educationally backward. Thus the aim of the introduction of this Village Extension Programme is to extend out to reach environmental awareness, social activities, hygiene, and health to the rural people of this region. The students in their third semester have to visit any one of the adopted villages within the jurisdiction of Alagappa University and can arrange various programs to educate the rural mass in the following areas for three day based on the following theme:

- Environmental awareness
- Hygiene and Health

A minimum of two faculty members can accompany the students and guide them.

12. Maximum duration for completion of the programme

The maximum period for completion of M.Sc. Degree in Fisheries Science shall not exceed eight semesters.

13. Commencement of regulation

These regulations shall come into effect from the academic year 2021-2022 for students who are admitted to the first year of the course during the academic year 2021-2022.

14. Industrial visit/Internship/Field/Institutional visit:

Students have to undertake an industrial / Internship/Field/ institutional visit/educational tour and have to submit a report for evaluation (Satisfactory / Not Satisfactory).

15. Classification of the successful candidate

The Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper. The students who have secured not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in First class. All other successful candidates shall be declared to have passed in the Second class. The candidate who obtains 76% of marks in the aggregate shall be deemed to have passed the examination in first class with distinction provide they should have passed all the examination at the first appearance.

Candidates who passed all the examinations prescribed for the course in the first instance and within two academic years from the year of admission to the course are alone eligible for university ranking.

A candidate is deemed to have secured the first rank provided if he/she should have passed all the papers in the first attempt itself and should have secured the highest Cumulative grade point average (CGPA).

Each student should earn **74 credits as core courses** including dissertation work and field trip, **12 credits as discipline specific electives**; **4 credits as a non-major elective**, in addition, **MOOCs courses as extra credits**, thus totaling at least 90+ extra credits required to complete M.Sc. Fisheries Science degree programme.

Raw score	Letter Grade	Description	Grade point
91 and above	S	First Class - Exemplary	9.01-10
76-90	D	First Class-Distinction	7.51-9.00
61-75	A	First Class	6.01-7.50
56-60	B	Second Class	5.51-6.00
50-55	C	Second Class	5.00-5.50
Below 50	RA	Re-appear	-
I - inadequate attendance; W-withdrawal from the course			

What to do after M.Sc.?

After the post-graduation, the candidates can go for the research field for further studies. They can take up Ph. D. in Fisheries Science, Fisheries Administration, employment in fisheries and allied sectors etc. Opting for the management degree is also another option for the PG holder. A management degree helps them to join business organizations engaged in Fishery associated product development/ marketing. The interested candidates can also start their career soon after the PG program. There are many opportunities for the M.Sc. candidates. The public sector as well as the private firms provides job openings for the right candidates. The candidates can work with the banks, educational institutes, fish farms, manufacturing units etc. after their post-graduation.

Job and Career options for M.Sc.

The increased demand for sea foods and the growth shown by the Fishing industry opens wider employment opportunities for the qualified candidates in the Fishery Sciences. The export of Freshwater and Marine products and the utilization of related products in the domestic markets have given tremendous boost to the employment opportunities in this field. The competition across the sector has increased drastically and it offers a higher pay pack for the professionals in the sector. Some of the job opportunities for the M.Sc. candidates are,

Employment Areas

1. All State Fisheries Departments in India
2. All Fisheries Universities and Educational Institutes in India
3. Fish Disease Diagnostic Centre and Aquariums
4. Consultancies in fish and prawn farming
5. Fish Farmers Development Agencies and Feed Manufacturing Units
6. Research Institutes (ICAR, ICMR, ZSI, BSI, MoEFs MOEn, CMLRI, NIOT, FSI, NIO etc.)
7. Ornamental Fish Culture and Breeding Centers
8. Aquaculture areas (Fish and Prawn Farms)
9. Fish Processing and Marketing Firms
10. Fish/shrimp Feed Marketing
11. Fish/shrimp Health product Marketing
12. Hatchery and Seed Production Companies
13. Net Making Units
14. Commercial Pearl Production Industry
15. International Organizations like FAO, NACA, INFOFISH, SEAFDEC
16. Nationalized Banks

Job Types

1. Aquaculture Entrepreneur
2. Fisheries Extension Officer / Technical Officer
3. Fisheries Extension Officer
4. Assistant Fisheries Development Officer
5. Consultant and Fish Breeders
6. R&D Professional
7. District Fisheries Development Officer
8. Export Manager
9. Feed Mill Manager
10. Hatchery/ Farm Operator
11. Fish Export Inspector, Aqua Culturist and Fishermen
12. Fisheries Inspector and Assistant Director of Fisheries
13. Fish Exporters and Hatchery Manager and Fish Traders
14. Processing and Production Manager

ANNEXURE - I

M.Sc., Fisheries Science – Programme Structure

S. No.	Paper Code	Title of the paper		Credits	Hours/ Week	Marks		
						I	E	Total
I Semester								
1	547101	Core 1	Integrated Taxonomy of Finfish and Shellfishes	3	3	25	75	100
2	547102	Core 2	Inland Fisheries	3	3	25	75	100
3	547103	Core 3	Coastal and Marine Fisheries	3	3	25	75	100
4	547104	Core 4	Finfish and Shellfish Biology	3	3	25	75	100
5	547105	Core 5	Aquatic Ecology and Biodiversity	3	3	25	75	100
6	547106	Core 6	Lab-I	4	8	25	75	100
7	547107	Core 7	Field visit *	2	2	25	75	100
8	547501	DSE-1	Fish Genetics **or** Statistics in Fisheries	4	4	25	75	100
		Library / Yoga/ Counseling			1			
				25	**30**	**200**	**600**	**800**
II Semester								
9	547201	Core 8	Fishing Craft and Gears	3	3	25	75	100
10	547202	Core 9	Remote Sensing and GIS for Fisheries Management	3	3	25	75	100
11	547203	Core 10	Fishery Management, Regulations and Conservation	3	3	25	75	100
12	547204	Core 11	Freshwater Aquaculture	3	3	25	75	100
13	547205	Core 12	Research Methodology in Fisheries	3	3	25	75	100
14	547206	Core 13	Lab-II	4	8	25	75	100
15	547502	DSE- 2 Fishery Economy and Extension **or** Aquatic Pollution		4	4	25	75	100
16		Non-Major Elective		2	3	25	75	100
17		Self-Learning Course (SLC) –MOOCs		Extra credit				
				25	**30**	**200**	**600**	**800**
III Semester								
18	547301	Core 14	Shellfish and Finfish Hatchery Management	3	3	25	75	100
19	547302	Core 15	Coastal Aquaculture and Mariculture	3	3	25	75	100
20	547303	Core 16	Aquariculture and Live Feed Production	3	3	25	75	100
21	547304	Core 17	Aquatic Animal Health and Management	3	3	25	75	100
22	547305	Core 18	Fish processing Technology and Quality Assurance	3	3	25	75	100
23	547306	Core 19	Lab-III	4	8	25	75	100
24	547503	DSE-3 Fish Nutrition and Feed Technology **or** Integrated Fish Farming		4	4	25	75	100
25		Non-Major Elective		2	3	25	75	100
26		Self-Learning Course (SLC) –MOOCs		Extra credit				
				25	**30**	**200**	**600**	**800**
IV Semester								
27	547999	Core 20	***Dissertation Work or Internship Programme	15	30	50	150	200
				15	**30**	**50**	**150**	**200**
			Total	**90**		**650**	**1950**	**2600**

1. Discipline-Specific Elective Courses (DSE) – Student Choice and it may be conducted by parallel sections
2. * Field Study- Students have to go to fish landing center and submit the report –Two midterm evaluation (internal) through Viva voce + attendance (25 marks) , Field visit report -50 Marks +25 (Viva voce)=75 Marks
3. **SLC- Self Learning Courses (MOOCs) on Voluntary basis
4. *** Dissertation / internship report –Marks -Viva-voce (50) + thesis (100) + internal (50) = 200

NON-MAJOR ELECTIVE COURSES FOR OTHER DEPARTMENTS

1. Integrated Fish Farming

2. Aquariculture and Live Feed Production

3. Aquatic Ecology and Biodiversity

SEMESTER -I			
Course Code: 547101	**Integrated Taxonomy of Finfish and Shellfishes**	**Credits: 3**	**Hours/Week: 3**

Objective

- To understand the basic principles of taxonomy, classifications, and the characteristics of different finfish and shellfishes
- To understand the applications of molecular tools for fish identification.

Unit –I	**Principles of Taxonomy**: Linnaeus and the origin of classification, taxonomic characters, Theories of taxonomy, Nomenclature - types. Classification and interrelationships. Criteria for generic and specific identification. Preservation, cataloguing, submission in museums (National Digital Repository for Museums of India) and maintenance of specimens.
Unit –II	**Crustacean**: Taxonomic classification of commercially important crustacean up to genus level - Morphomertic and meristic characteristics of Crustacean. Key characters for identification - commercially important species.
Unit –III	**Mollusca**: Taxonomic classification of commercially important mollusks up to genus level - Morphological characteristics of mollusca. Key characters for identification - commercially important species.
Unit –IV	**Finfish Classification:** Taxonomic significance- Major taxa of commercially important inland and marine finfishes -Morphometric and meristic characteristic features of finfishes. Key characters for identification - commercially important species.
Unit –V	**Molecular Taxonomy**: Karyo-taxonomy, Cytotaxonomy of fishes - protein analysis and DNA polymorphism. Mitochondrial DNA- allozyme analysis, RFLP, RAPD, AFLP, microsatellite typing, single nucleotide polymorphism (SNP), and expressed sequence tag (EST) markers, DNA barcoding, NCBI - BLAST- MEGA - Phylogenetic tree.

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Lagler, K.E. et al. (1977). Ichthyology. John Wiley and Sons. Rd Eds.

Mayer, E. (1977). Principle of Systematic Zoology. Tata McGraw Hill.

Joseph Nelson, S., Terry Grande Mark, C., Wilson, V. H. (2016). Fishes of the World. 5th Eds. Wiley

Norman, J.R., Greenwood, P.H. (1975). A History of Fishes, 3rd Ed. Ernest Benn Ltd.

Ponniah, A.G., George, J. (1998). Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

Whitmore, D.H. (1990). Electrophoretic and Isoelectric Focusing Techniques in Fisheries Management. CRC Press.

Outcomes

- By the end of the course, students acquire comprehensive knowledge and also exhibit depth and breadth of fishery taxonomy.
- Students can be able to identify the commercially important fishes using molecular tools

SEMESTER -I			
Course Code: 547102	**Inland Fisheries**	**Credits: 3**	**Hours/Week: 3**

Objective

- To familiarize the students with the basic concepts and principles of Inland fisheries resources
- To discuss the lakes, ponds and riverine fisheries of India

Unit –I	**Introduction to inland fisheries** –History, national and international status of Inland fisheries - Global and Indian inland capture fishery resources, problems and management of the fisheries resources. Inland fishery sectors - government and NGOs role in the fishery developments.
Unit –II	**Freshwater fisheries resources**: Ponds, Lakes - Natural *vs* Man-Made Lakes –present status, productivity levels and management practices, Beels, tanks and derelict water bodies - major fish composition - diversity - Problems and management aspects. Potential inland water bodies with reference to respective state-problems and management aspects.
Unit –III	**Swamps and other wetlands:** Introduction – Jeels /Beels Fishery resources – status - environmental sustainability and livelihood security - productivity, conditions, capture scenario, prospects of culture-based systems. Degradation - impact of climate change - adaptation and mitigation strategies. **Reservoir Fisheries**: Classification of reservoirs, present productivity levels and management practices.
Unit –IV	**Riverine fisheries resources**: Present trend of dwindling fisheries resources, direct and indirect effects of human intervention in rivers, habitat modification and improvement, protection and restoration of fish movements (different types of fish passes and enhancement of fish migration) and repair of riverine vegetation, stock enhancement, strategies like introduction of new species, pre- and post- stocking management, potential risk of stocking. Exotic species diversity - merits and demerits of exotic species.
Unit –V	**Cold water fisheries of India**: Present trends, problems due to habitat destruction, management aspects, prospects of sports fisheries in India- Fishing Tackle -Types of gear used in angling. Sport fisheries potentials in Himalayan - factors affecting fishing - suggestions to promote sport fisheries. **Assessment**: Carrying capacity of different inland water bodies; Water budgeting. Community participation in fishery resource management.

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Sarma, D., Shahi, N. (2020). Coldwater Fisheries and Aquaculture. Narendra Publ. House.

Outcomes

- After completion of this course, students may gain significant knowledge on the inland fishery recourses.
- The student can critically assess the inland fishery resources and conserve fish diversity.

SEMESTER -I			
Course Code: 547103	**Coastal and Marine Fisheries**	**Credits: 3**	**Hours/Week: 3**

Objective

- To familiarize the students with the basic concepts and principles of coastal and marine fishery resources
- To discuss estuaries, mangrove ecosystems, lagoons and marine fisheries of India.

Unit –I	**Introduction to coastal and marine fisheries:** History, national and international status of fisheries - lagoons, mangroves, estuaries, backwaters and brackish water impoundments in India and their fishery resources.
Unit –II	**Fishery resources**: Important finfish and shellfish resources in demersal, pelagic brackish water systems; conservation strategies. Principles, objectives and management of fisheries resources- issues and challenges of managing multi-gear fisheries.
Unit –III	**Mangrove fishery**: Introduction, national and international status - Fishery resources – status - environmental sustainability and livelihood security - productivity, conditions, capture scenario, prospects of culture-based systems. Degradation - impact of climate change.
Unit –IV	**Fisheries and fishing methods**: Introduction to Crafts and Gears, Inshore fisheries (up to 50 m depth), Offshore fisheries (50-200 m depth), High sea fisheries (beyond 200m) up to outer limit of EEZ and in International waters. Sustainability of fisheries: Principles, social, economic, ecological, biological and legal issues - Fisheries co-management. Illegal Unreported and Unregulated (IUU) fishing - national and international status.
Unit –V	**Conservation**: Marine biodiversity - principles, categorization of species into endangered; Indeterminate and extinct varieties - conservation in selected area – coral reef ecosystem - managing the highly exploited fishery resources - Case studies of fisheries conflicts depending on problems in different states. Bioinvasion.

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Outcomes

- After completion of this course, student can gain significant knowledge on coastal and marine fisheries.
- The student can analyse coastal and marine fishery resources and able to conserve the fishery biodiversity.

SEMESTER -I			
Course Code: 547104	**Finfish and Shellfish Biology**	**Credits: 3**	**Hours/Week: 3**

Objective

- To understand the fundamentals of anatomy and biology of finfishes
- To study the different biological systems of shellfishes

Unit –I	**Finfish:** Biology of commercially important freshwater and marine finfishes – Physiology of fishes - life cycle - food and feeding habits - age & growth - role of endocrine system in reproduction - migration.
Unit –II	**Prawn and Shrimp**: Commercially important prawn and shrimps - life cycle - larval stages - food and feeding habits - age & growth - role of endocrine system in reproduction - migration.
Unit –III	**Crab and lobster:** Commercially important crab and lobster - life cycle - food and feeding habits - age & growth - role of endocrine system in reproduction - migration.
Unit –IV	**Bivalves**: Clam, oyster, green and brown mussel - present national and international status - life cycle - food and feeding habits - age & growth - reproductive biology.
Unit –V	**Gastropods**: Commercially important freshwater snails and Abalone - life cycle - food and feeding habits - age & growth - reproductive biology. **Cephalopods** - squid, octopus, cuttlefish, commercially important species - life cycle - food and feeding habits - age & growth - reproductive biology.

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Outcomes

- The student can be able to critically discuss the biology of finfishes and shellfish
- The student understands the physiology of commercially important Fishes

SEMESTER -I			
Course Code: 547105	**Aquatic Ecology and Biodiversity**	**Credits: 3**	**Hours/Week: 3**

Objective

- To acquaint the students with the theoretical and practical aspects of the aquatic environment
- To teach the aquatic biodiversity and conservation.

Unit –I	**Concepts in aquatic environment**: Aquatic environment/ecosystem – components - structure and functions; Ecological concepts – succession, homeostasis, natality and mortality, r and k selection; Concepts of habitat and ecological niche; carrying capacity.
Unit –II	**Aquatic ecology**: Freshwater, estuarine and marine - Biotic features of a freshwater, ecosystem. Estuarine and marine ecosystem - classifications, biological features of Coral Reefs, Seaweeds, Seagrasses and Mangroves. Deep sea ecosystem and Hydrothermal vent community. Natural resources and their conservation - Satellite mapping.
Unit –III	**Biological Ecosystem**: Environmental factors influencing life in the oceans: Salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Phytoplankton and Zooplankton, interrelationship, vertical migration of zooplankton, geographical and seasonal variation in plankton production, plankton and fisheries.
Unit –IV	**Bio-geochemical cycle**: Definition, general concept of complete and incomplete bio-geochemical cycles, sedimentary cycles in tropics. Environmental concerns: population explosion, industrialization, urbanization, and natural calamities; Overexploitation of resources; Environmental stresses; Pollution control and management - Global warming; Ocean acidification, Carbon credit, Ozone Depletion.
Unit –V	**Biodiversity**: Definition and concept. Factors influencing aquatic biodiversity. Types of biodiversity - Species diversity, Genetic Diversity, and Habitat Diversity; Biodiversity indices and their significance; Concepts of Index of Biotic Integrity (IBI); Economic appraisal of biodiversity; Global diversity patterns and loss of biodiversity.

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Outcomes

- The student proficiently discuss about the aquatic ecosystem and biodiversity of fishes
- Student can discuss and analysis the fishery diversity and conservation.

SEMESTER -I			
Course Code: 547106	**Lab –I**	**Credits: 4**	**Hours/Week: 8**

Objective

- To identify and familiarize with commercially important shellfish and finfish
- To gain practical knowledge on Inland, coastal and marine fishery resources
- To make acquainted in the aquatic animal diversity

Unit –I	**Taxonomy**: Identification of commercially important freshwater, coastal and marine finfish, crustacean, Mollusca - morphometric and meristic characters – DNA bar coding and phylogenetic analysis.
Unit –II	**Inland fisheries**: Different types of tags – case study. Visit to nearest freshwater body. Catching methods – catch data analysis on major freshwater resource – Reservoirs – lakes - Biodiversity indices – Gear selectivity.
Unit –III	**Coastal and Marine fishery resources:** Case study - visit to nearest coastal and marine landing center – length frequency analysis – catching method – catch data analysis on marine fishery resources of India – closed season studies – gear selectivity.
Unit –IV	**Biology of finfish and shellfish**: Estimation of oxygen consumption and rate of respiration in a fish – marine and freshwater fish gut analysis –display various organs of shellfish and finfish.
Unit –V	**Aquatic ecology**: Plankton - collection and identification from different aquatic ecosystem – estimation of salinity, DO, pH, ammonia, nitrite, nitrate, inorganic phosphate, BOD and COD. Identification of mangroves, seaweeds, seagrass and important aquatic animals.

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Outcomes

- After completion of this course, students are able to identify the commercially important phytoplankton, zooplankton, fishes and other aquatic plants and animals.
- Students can be able to analyze water quality parameters independently.

SEMESTER –I Discipline Specific Elective			
Course Code: 547501	**Fish Genetics**	**Credits: 4**	**Hours/week: 4**

Objective

- To study the fish genetic resources
- To study the fish conservations

Unit –I	**Introduction**: Definitions, the scope of genetics, Mendelian principles and contribution, polygenic inheritance, multiple alleles, sex determination, sex-linked-inheritance and pedigree analysis, simple Mendelian traits.
Unit –II	**Principles of genetics:** Interactions and environmental influences - Molecular genetics: Concept of gene - gene expression, gene expression control in eukaryotic, prokaryotes and phages. DNA mutation and recombination. Genetic regulation of development and differentiation. DNA bar-coding.
Unit –III	**Practical application of Genetics:** Hybridization of fishes, recent trends and techniques in hybridization, selective -breeding, cross breeding, development of disease resistance and high quality of new strains - transgenic fish production. Cryopreservation techniques.
Unit –IV	**Chromosome manipulation:** Its role in aquaculture, androgenesis, gynogenesis, sex reversal and tripoidy, conservation of germplasm. Transgenic fish - Fish Genetic recourses-collection and preservation of genetic recourses - importance of fish gene banking.
Unit –V	**Diversity:** Genetic diversity and Habitat Diversity - importance, estimation and influencing factors; Determination of sample size. Introduction to population genetics, Hardy - Weinberg law and its significance. Markers used in genetic assessments – allozymes, mitochondrial DNA & microsatellites. Genetic drift- consequences of random genetic drift.

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Outcomes

- Student can critically discuss the fish genetics and resources
- Student can acquire through knowledge on fish conservations and gene banking.

SEMESTER -I Discipline specific electives			
Course Code: 547501	**Statistics in Fisheries**	**Credits: 4**	**Hours/Week: 4**

Objective

- To impart the national and international fishery resources
- To provide knowledge on National and international aquaculture statists

Unit –I	**Definition and Introduction** : Sample Survey for estimation of inland and marine fishery resources and their potential - Census on Marine Fisheries, Catch Assessment Survey of Inland and Marine Fisheries, Development of Geographical Information System (GIS) based fishery management system, Development of Database of fishery cooperatives of India, Mapping of Smaller Water Bodies.
Unit –II	**Production:** Fish production - National and International status - National production and disposal – State/union territory wise – inland and marine fish production - Species wise – Inland and Marine Fish Landings - capture fishery production – inland and marine – Aquaculture production state wise/UT wise - Fish Seed Production in India - Preservation and processing of fish.
Unit –III	**Fishery resources:** State and UT wise fishermen population - landing centers – major and minor - number and types of vessels and gears used –potential inland and marine fishery resources – National and international EEZ and its potential - government schemes and expenditure - Fishery institution of India.
Unit –IV	**International scenario:** India contribution of fishery products to world - fish production – annual growth - major countries of inland production – species wise – Major marine species production countries and their contribution.-International market trend and prices – species wise. Per capita fish consumption.
Unit –V	**Fishery welfare:** Fishermen welfare – government schemes – State wise details of fund released under the Central Sponsored Scheme on National Scheme of Welfare of Fishermen, future prospectus - role of NFDB in fishery development and their schemes - Code List of States/ UTs and Districts.

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Outcomes

- Students gain with knowledge on the capture and culture fishery status
- The Students are able to analysis fishery development and requirement.

SEMESTER -II			
Course Code: 547201	**Fishing Craft and Gears**	**Credits: 3**	**Hours/Week: 3**

Objective:

- To learn fishing craft and gear technology
- To design and modification of existing fishing gears.

Unit –I	**Introduction to Fishing crafts:** History, traditional and modern inland and marine fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. Basic geometric concepts and important terminologies of fishing vessel. By using Trapezoidal rule and Simpson's rules. State of equilibrium; various equilibrium of ships - Tonnage system and types.
Unit –II	**Crafts design and construction:** Fishing craft materials - wood, steel, aluminum, Ferro-cement, FRP (GRP) - advantages and disadvantages. Parts of different crafts: Offset tables; Mould lofting; Backbone assembly of wooden boat. Classification of outboard and inboard engines - General arrangements of different type of fishing crafts: trawlers, gill netters, purse seiners, long liners and deep sea vessels. Maintenance of different fishing crafts from corrosion.
Unit –III	**Introduction to fishing gear:** History, traditional and modern inland and marine fishing gears. Basic principles of fishing gear. Factors affecting fishing gear - different fishing gear materials based on species. Yarn numbering systems – different netting / webbing, mounting of webbing and methods of mounting; Floats, sinkers and types - Other accessories; Maintenance and storage of gears.
Unit–IV	**Fishing Gears:** Passive fishing gears: types, principle, operation and target group of inland and marine species. Active fishing gears: types, principle, operation and target group of inland and marine species. Gears according to the different inland ecosystem - Fishing without gear - Fishing by hunting - Fishing with animals - Grappling and wounding gears - Stupefying gears**.** Destructive and prohibited fishing practices. By-catch: definition, types of by catch and principles of operation. Electronic equipments for fishing. Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipments.
Unit –V	**Regulations for craft and gears:** Concept of Responsible Fisheries; Monsoon trawl ban, closed season, mesh size regulations, juvenile fishing, Exclusive Economic Zone (EEZ), Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM). MSY, MEY, Over fishing, Recruitment over fishing, Aqua-ranching. Indian fisheries Act. Coast Guard Act. Maritime zones of India Act.

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Outcomes

- Students gain knowledge on the different types and method of fishing crafts and gears used in the coastal and marine ecosystems.
- Students can critically discuss about the various crafts and gears used in the freshwater fishery.

SEMESTER -II			
Course Code: 547202	**Remote Sensing and GIS for Fisheries Management**	**Credits: 3**	**Hours/week: 3**

Objective

- To learn the role of remote sensing in fishery
- To be acquainted with the satellite information and its application in fisheries management

Unit –I	**Introduction to remote sensing**: History- traditional methods of fishery management - overview of operational fisheries in pelagic and deep sea fisheries - Current problems in fisheries management - Present global and Indian status of remote sensing application in fisheries.
Unit –II	**Basic terms and concepts:** Electromagnetic radiation and its properties, atmospheric interactions, target interactions. Warning system.
Unit –III	**Sensor platforms:** Boats, balloons, air-crafts and satellites, Sensor systems – global acquisition systems and sequential acquisition systems.
Unit –IV	**Environmental satellites:** The Land sat series, NOAA and IRS; Digital image processing and interpretation.
Unit –V	**GIS in Fisheries**: Elements of GIS, Application of remote sensing and GIS to fisheries and aquaculture planning and development. Challenges of fisheries information systems and future perspectives.

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Outcomes

- After completion of this course, student can critically discuss about the importance of remote sensing in fishery
- Student can able to apply GIS for sustainable fisheries and aquaculture development.

SEMESTER -II			
Course Code: 547203	**Fishery Management, Regulations and Conservation**	**Credits: 3**	**Hours/week: 3**

Objective

- To understand the importance of enforcement of fisheries regulations and policies
- To study the fishery conservations

Unit –I	**Regulations**: Fisheries regulatory and developmental setup in Centre and States and their spheres of responsibility; need for fisheries management; regulatory, legal and enforcement regimes. Illegal, unreported and unregulated fishing. The Indian Ocean Tuna Commission (IOTC) - management of tuna and tuna-like species in the Indian Ocean.
Unit –II	**Monitoring, Control and Surveillance:** MCS systems for capture fisheries: Inland, coastal and marine capture fishery MCS. Code of Conduct for Responsible Fishing: Mesh size regulations - Best Management Practices in fisheries.
Unit –III	**Deep sea fishing regulations**: Regulatory and developmental issues concerning deep sea fishing – Guidelines for operation. Maritimes Zones of India Acts (Regulation of fishing by Foreign vessels). Draft Marine Fisheries Policy.
Unit –IV	**Marine fisheries and aquaculture legislations**: States wise fishery legislations of India - Coastal Aquaculture legislations-Management needs associated with aquaculture development; Coastal Regulation Zone (CRZ) in the context of aquaculture. Sustainability, Integrated Coastal Zone Management and ecosystem management.
Unit –V	**Water policies**: National Water Policy; water needs for agriculture, industry, portability and fisheries, fishing rights in open waters; and role of fisheries cooperatives, aqua/ecotourism. Concepts and implication of Interlinking of rivers on fisheries and biodiversity. Pollution act.

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Outcomes

- Students can critically discuss the importance of fisheries regulations and policies
- Students acquire the fundamental knowledge on the fishery conservation

SEMESTER -II			
Course Code: 547204	**Freshwater Aquaculture**	**Credits: 3**	**Hours/week: 3**

Objective

- To learn the basic concept of freshwater aquaculture for sustainable production
- To familiarize with freshwater aquaculture cultivable species, hatchery technology and farming

Unit –I	**Introduction**: Present status, problems and scope of fish and prawn farming in global and Indian perspective. Major cultivable freshwater species. Aquaculture systems: Extensive, semi-intensive and intensive culture of fish, Pen and cage culture in lentic and lotic water bodies, polyculture, composite fish culture-species selection, culture practices, harvesting.
Unit –II	**Aquaculture engineering**: Hatchery design and equipments – Small, Medium and Large scale hatchery for freshwater finfish and prawn. Farm design and equipments - Small, Medium and large scale farming for freshwater finfish and prawn.
Unit –III	**Hatchery and nursery:** Present global and Indian status of freshwater hatchery - Commercially important Finfish and prawn seed production – Broodstock collection-quarantine – larval rearing – live feed production - feed, water quality and health management. Nursery - Finfish and prawn nursery management – cost analysis for hatchery and nursery.
Unit –IV	**Farming**: Present global and Indian status of freshwater finfish and prawn farming – Monoculture – polyculture - composite culture. Genetically Improved Farmed Tilapia - Production – monosex – Tilapia - All male Scampi production. Finfish and prawn farm management – pond preparation - water culture – stocking – feed, water and health management. Sampling procedure – harvesting. Recent management techniques – Biosecurity – Biofloc - HACCP. Freshwater pearl culture.
Unit –V	**Integrated farming systems**: Design, farming practices, constraints and economics of IFS of fish with paddy, cattle, pig, poultry, duck, rabbit, etc. Culture of fishes in the community ponds – Wastewater - fed aquaculture: Water treatment methods, species selection, culture practices, harvesting. Cold water aquaculture – present status – important species – hatchery and farming. Aquaphonics - types and production system.

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Outcomes

- Students gain knowledge on seed production of Indian fresh water prawn major carps, Exotic carps, Minor carps, Murrells.
- Students acquire skill on sustainable freshwater finfish and prawn farming.

SEMESTER -II			
Course Code: 547205	**Research Methodology in Fisheries**	**Credits: 3**	**Hours/week: 3**

Objective

- To recognize the essential components of research and its methodology in fisheries
- To identify an appropriate fishery research problem and to solve them

Unit –I	**Literature survey**: Collection of research literature, design a research projects, analysis, compilation and presentation of research data, preparation of transparencies, research papers, dissertations, oral and visual delivering of results. H-index , I-10 index – citation index – calculation - research gate – Scopus index - Google scholar citation etc.
Unit –II	**Laboratory practices and spectral analysis:** Good laboratory practices. Normality and Molarity calculation. Working principle and applications of pH meter, UV-visible, Spectrophotometer, Fourier Transform – Infrared spectrophotometer, flame photometer, Atomic Absorption Spectrophotometers, Nuclear Magnetic Resonance, and Mass spectrophotometer.
Unit –III	**Chromatography and Molecular techniques**: Principles and use of Centrifuges, Chromatography (Paper, thin-layer, and column chromatography), Electrophoresis, ELISA, PCR, RT-PCR, Blotting Techniques, Microarray techniques.
Unit –IV	**Microscopy and Histology**: Principles and application of Light Microscopy: Bright field, Dark field, Phase contrast, Differential Interface Contrast Microscopy, Fluorescence Microscopy, Confocal Microscopy. Electron microscopy: Scanning and Transmission. Principles and application of Histology and Histochemistry.
Unit –V	**Biostatistics**: Sampling or census methods - random and non-random technique – Data collection. Description statistics of central tendency and dispersion – mean, median, mode, standard deviation, standard error. Probability distribution, data - binominal, Poisson and normal distribution. Relational statistics of correlation and regression – Student's' test, ANOVA – one way and two-way analysis. Manuscript Preparations: literature collection - preparation of dissertation/thesis - preparation of scientific paper for publication in a peer reviewed journal.

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Outcomes

- Students can able to perform literature reviews using print and online databases and identify, explain, compare, and prepare the key elements of a research proposal/report.
- Gain knowledge on major research instruments.

SEMESTER -II			
Course Code: 547206	**Lab II**	**Credits: 4**	**Hours/week: 8**

Objective

- To understand the various craft and gears used for inland costal and marine fisheries
- To provide practical knowledge on remote sensing , regulations in fisheries and identification of freshwater cultivable species
- To learn sampling methods in aquaculture farms and find a research problems and gain knowledge on various instruments

Unit –I	**Craft and Gears**: Visit to boat building yards for on–the–spot study - Study of deck lay outs of different types of fishing vessels and preparation of sketches - Report. Gears: draw the different types of fishing gears used in inland, coastal and marine fishing.
Unit –II	**Remote sensing and GIS application in fisheries**: Study of satellite information, interpretation of satellite pictures for resource management, case studies on remote sensing and GIS applications.
Unit –III	**Fishery regulations**: Visit to appropriate Government/NGO and preparation of inland, coastal and marine fishery regulation working report.
Unit –IV	**Freshwater aquaculture:** Identification of commercially important cultivable fish and prawn - Sampling procedure - growth assessment - feed calculation. Lime, fertilizer and feed additive calculation.
Unit –V	**Research methodology**: Preparation of solutions – Molarity, Normality, Percentage – Buffer preparation, Determination of pH. Prepare report on instrumentation. Visit to common instrumentation facility and write the different instruments principles, its applications in fisheries.

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Outcomes

- Students can critically discuss about the various craft , gears, remote sensing applications in fisheries
- Students acquire practical knowledge on identification of cultivable freshwater fishes and sampling procedure.
- Students will gain knowledge on various instruments

Semester –II Discipline Specific Elective			
Course Code: 547502	**Fishery Economy and Extension**	**Credits: 4**	**Hours:/week 4**

Objective

- To impart theoretical knowledge on Fishery Economics and Marketing with application of new technique in fisheries science
- To study the concept, objectives and principles of fisheries extension

Unit –I	**Scope of Economics**: Bio-economic analysis of fisheries. Growth, development and natural resource interrelationships. Pricing and optimal resource use over time under different market situations - role of market structure, interest rate and property rights in fisheries exploitation.
Unit –II	**Concept of Economy**: Positive and negative externalities. Physical, legal and economic incentives to internalize the externalities. Fishery resource management policies markets, taxes, subsidies, permits, direct controls, distributional effects of fisheries development. Fisheries marketing and Organizations.
Unit –III	**Economics:** Principles; Factor-Product, cost principles, Factor-factor, Product-product and law of comparative advantage, law of equimarginal returns, returns to scale and farm size, Homogeneous production functions; Cobb-Douglas and quadratic production functions. Fisheries and Socio-economic Analysis, meaning and measurement of socio-economic variables. Factors determining development. Role of sociology in the process of fisheries development. PRA and RRA for studying socio-economic problems, stake holder analysis.
Unit –IV	**Fisheries extension**: History - role of extension in fisheries development. Extension methods individual, group and mass contact methods and their effectiveness, factors influencing their selection and use. Characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management.
Unit –V	**Extension planning and evaluation**: Various steps and importance; participatory, planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

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Outcomes

- The student will acquire knowledge on fishery economics and proficient to critically discuss the subject on Fishery economics
- The student will be able to understand fishery extension and talented to implement extension activity.

SEMESTER –II - Discipline specific electives			
Course Code: 547502	**Aquatic Pollution**	**Credits: 4**	**Hours/Week: 4**

Objective

- To teach fundamental and basic knowledge on different aspects of aquatic pollution
- To educate Aquatic pollution management

Unit –I	**Aquatic pollution:** Current national and international status of aquatic pollution. Pollution sources, types and their impacts; Pollution problems of groundwater resources –sources of contamination, management issues - Methods of aquatic pollution surveys.
Unit –II	**Pollutants:** Sewage, pesticides, oils, metals, radioactive wastes, biomedical wastes, etc. Common transport processes of pollutants in the aquatic environment; dispersal of pollutants; eutrophication and their management- bioaccumulation - Minamita, *itai itai*, etc. and their toxic effect.
Unit –III	**Wastewater management**: Wastewaters - classification and characteristics of sewage and industrial effluents; treatment methods for water and waste water; Principles of aeration, chlorination, ozonation and U.V. irradiation. Waste disposal and water quality criteria used in different parts of world - national and international standards; ISO-14000(EMS), EIA, Management strategies.
Unit –IV	**Waste recycling and utilization in aquaculture**: Design and construction of water filtration devices; aerobic and anaerobic treatment of wastewater. Wastes from fish processing units and their treatment; solid waste management; removal of nitrogen and phosphorus from waste water; Role of aquatic macrophytes in treatment of wastewater.
Unit –V	**Monitoring Strategy:** Pollution control and management – Ocean acidifications – current status of global warming-Indicator organisms - Criteria for selection of indicator organism: Red tides phenomena: Monitoring strategies of marine pollution: Mitigation - Global warming and Climate change. Role of international and national organizations and role of NGO.

References

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Outcomes

- The student can able to critically discuss aquatic pollution
- The student will able to analyse and implement aquatic pollution management as per the government standards.

SEMESTER -III			
Course Code: **547301**	**Shellfish and Finfish Hatchery Management**	**Credits: 3**	**Hours/week: 3**

Objective

- To study the various cultivable aquaculture species seed production
- To learn hatchery skills for finfish and shellfish seed production

Unit –I	**Introduction**: History, constraints and current international and national status of finfish, shrimp, crab and molluscan hatchery – Biology and life cycle of cultivable finfish and Shellfishes.
Unit –II	**Hatchery Engineering**: Site selection – design – construction – equipments - water filtering systems - layout and design of hatchery sections – quarantine - brood stock – spawning - larval rearing – post larval - nursery for different species.
Unit –III	**Crustacean seed production**: Prawn – Shrimp - Crab and lobster - brood stock collection - quarantine and broodstock management – stocking – selective breeding - induce breeding - water quality – feed and health management. Shrimp captive brood stock development - SPF seed production - HACCP. Nursery technology.
Unit –IV	**Molluscan seed production**: Green and brown mussel - oyster – edible and pearl oyster-abalone – scallop - brood stocks collection – induce breeding – water – feed - health management.
Unit –V	**Finfish seed production**: Freshwater – Carp - Catfish and Murrells – Tilapia - Coldwater fish - Trout. Coastal and marine Finfish seed production – milkfish – mullets – sea bass-grouper – cobia – pompano - brood stock development, induced breeding - larval rearing – water – feed and health management. Nursery management for different finfish species.

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Outcomes

- Students acquire in depth knowledge on seed production of finfish and shellfish.
- Students are able to work in the hatchery after completion of this course.

SEMESTER -III			
Course Code: 547302	**Coastal Aquaculture and Mariculture**	**Credits: 3**	**Hours/week: 3**

Objective

- To teach coastal aquaculture and mariculture skills
- To provide recent knowledge on farming systems for sustainable production

Unit –I	**Coastal aquaculture**: History, global and Indian status of coastal aquaculture – Principles to sustainable aquaculture development - Types of culture - farm design – infrastructure facilities for shellfish and finfish species.
Unit –II	**Mariculture**: History, present global and Indian status of Mariculture – cultivable species-Cage, Pen and raft – different types of cages – raw materials – constructions. Mariculture international and national regulation.
Unit –III	**Crustacean Farming:** Shrimp-crab-lobster. Pond preparation, soil culture – water culture - – acclimatization – stocking - water quality – feed - health management - Biosecurity – HACCP and Biofloc technology in shrimp farming. Seaweed culture, Recirculation aquaculture system, Integrated multi-trophic aquaculture.
Unit –IV	**Molluscan Farming**: Mussels – oyster – abalone – scallop - pearl oyster culture - types of culture - stocking - water quality, feed and health management. Major problems in farming in India.
Unit –V	**Finfish farming**: Cultivable species – types of culture - site selection – pond preparation – soil culture - water culture - stocking – feed management – water quality parameters and management –health management – Recirculating aquaculture system - Biofloc technology - Biosecurity procedure for fish farming.

References

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Outcomes

- After completion this course, student acquires skill in seed production of major cultivable finfish and shellfishes
- Students will be talented in the farming system and proficient in recent faming technology.

SEMESTER -III			
Course Code: 547303	**Aquariculture and Live Feed Production**	**Credits: 3**	**Hours/week : 3**

Objective

- To impart knowledge on ornamental aquaculture and aquarium keeping
- To teach live feed culture for ornamental fish production

Unit –I	**Ornamental fish introduction**: History – international and national status. Capture and cultivable ornamental fishery recourses. Aquarium plants - Different freshwater fishes – indigenous and exotic species and marine species. Biology and life cycle of different finfish and shellfish species.
Unit –II	**Infrastructure facilities and equipments:** Site selection – layout – design – construction - equipments required for freshwater and marine ornamental hatchery and farm production. Aquaponics – Types - infrastructure facilities – layout – model - plant and fish species cultured. Aquarium – freshwater and marine aquarium design - different models - aquarium accessories.
Unit –III	**Ornamental fish production**: Farming management –Types of marine and freshwater and marine ornamental fish – water quality – feed and health management. Arowana – flower horn - koi carp - gold fish - angel – discuss – breeding and faming. Marine Clown Fish, Damsel Fish, Marine Angels, Butterfly Fish etc. - hatchery and farm management. Coldwater ornamental fish production. Cross breeding and selective breeding. Good Management Practices.
Unit –IV	**Live feed production for aquarium:** Freshwater and marine species - phytoplankton and zooplankton production – different media – water quality parameters - health management – quality control. Live feed production human consumption - species – international and national status - culture methods and mass scale production.
Unit –V	**Marketing**: Present status - national and international trading for marine and freshwater ornamental fishes. High value freshwater and marine ornamental fishes. The world most beautiful fishes market price and demand and future prospects. Live feed market potential – national and international status - Market price and demand - marketing methods-different organization – MPEDA – regulations for export and import – government subsidies.

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Outcomes

- Students gain in depth knowledge on freshwater and marine ornamental fish production
- Students can design aquarium and understand the market potential of ornamental fishes.

SEMESTER -III			
Course Code: **547304**	**Aquatic Animal Health and Management**	**Credits: 3**	**Hours/week: 3**

Objective

- To teach fish immunology and disease transmission
- To become skilled in aquatic animal disease diagnosis and management

Unit –I	**Finfish and shellfish immunology**: International and national status of finfish and shell disease. Host-pathogen-environment relationship. Environmental stress. Immune system in fish and shellfish: innate and acquired immunity, inflammation response to diseases. Antibody and cell mediated immunity in finfish and shellfish.
Unit –II	**Bacterial and viral diseases**: Bacterial and viral diseases of finfish and shellfish - general characteristics, diagnosis, mode of transmission, prevention and treatment. Environment management, chemotherapeutic agents, host management, prophylaxis - vaccines, adjuvants, immunostimulants, prebiotics and probiotics. Use and abuse of antibiotics and chemicals in health management and alternatives to antibiotics.
Unit –III	**Parasitic and mycotic diseases**: Parasitic and mycotic diseases of finfish and shellfish disease - general characteristics, epizootiology, diagnosis, life cycle, prevention and treatment. Environment management, chemotherapeutic agents, host management, prophylaxis- vaccines, adjuvants, immunostimulants, prebioitcs and probiotics.
Unit –IV	**Non-infectious Diseases**: Finfish and shellfish nutritional diseases in hatcheries and grow out systems. Identification, diagnosis, prevention and control. **Techniques in health management:** microbiological, haematological, histopathological, immunological and molecular techniques.
Unit –V	**Quarantine**: Fish health and quarantine systems, national and international status-importance. Design of quarantine and equipments for fish and shellfish brood stock maintenance - Seed certification, SPF and SPR stocks development and management - cost analysis.

References

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Outcomes

- After completion of this course, students can be able to critically discuss various fish disease
- Students become skilled in aquatic animal disease management

SEMESTER –III			
Course Code: 547305	**Fish Processing Technology and Quality Assurance**	**Credits: 3**	**Hours/week: 3**

Objective

- To learn the techniques for bulk fish preservation, processing, production and purification in technology concern

Unit –I	**General introduction**: History and status of processing technology - Biochemistry of fish - Biochemical changes after fish death. Types of fish spoilage, causative factors – autolytic spoilage, microbial spoilage, oxidative changes. Post-harvest management for finfish and shellfishes: Grading of fish, fish quality evaluation - Packing, different storage procedure and transportation up to process plants- Quality assurance in Post-harvest.
Unit –II	**Processing methods**: Principles and different methods of chilling, Freezing: Air Blast Freezers, Plate freezers- Horizontal, vertical, IQF – Brine freezer, other freezers. Irradiation methods of preservation and Pasteurization for different fishery products. Salt curing - conventional and modern methods of drying (Solar driers) - pickling and smoking. Biochemical changes during processing.
Unit –III	**Canning:** Introduction, history, status, products, types of canning – processing - seaming – types of canned products – finfish and crustaceans. Problems related to canning.
Unit –IV	**Fishery By-products**: Fish silage – Definitions - methods – production and uses – Fish hydrolysate, Fish meal, bone meal, fish oil, surgical sutures from intestine, chitin, chitosan and etc. Additives and preservatives. Value added products – type of products - processing methods.
Unit –V	**Quality Control, Packaging and Marketing**: Quality control and quality assurance – HAACP, USFDA, EU, BIS, BRC, Good Management Practices etc. for different fish products and processing techniques. Packing: materials sources – types – packing - quality assurance during packing. Trading: role of EIA and MPEDA. Inland and export trade. Fast Moving Goods (FMG) – Products – retail marketing - chilled and frozen product market. Logistic management and quality assurance of fishery products.

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Outcomes

- The student will be able to discuss various fish processing methods
- The student acquire knowledge on quality assurance in seafood processing and critically discuss the HACCP.

SEMESTER -III			
Course Code: 547306	**Lab III**	**Credits: 4**	**Hours/week: 8**

Objective

- To educate practical skill in identification of cultivable finfish and shellfish, techniques in breeding
- To provide practical knowledge on aquarium setup and quality assurance of fish

Unit –I	**Costal aquaculture and Mariculture**: Identification of cultivable marine and brackish water finfish and shellfish. Identification of cultivable seaweeds. Designing of different farming systems – cages, pens, rafts and racks.
Unit –II	**Finfish fish and shellfish hatchery**: Technique of induced breeding- eggs, larval and post-larval stages of shrimp, prawn, crab, fin-fish -stocking size, counting methods of eggs and larvae hatchery. Seed packing.
Unit –III	**Aquariculture and live feed production**: Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Identification phytoplankton and zooplankton.
Unit –IV	**Aquatic Animal Health**: General procedures for disease diagnosis; Taxonomy and identification of fish parasites; Sampling, preparation of media and culture of pathogenic bacteria; Techniques for bacterial classification; Histological techniques for disease diagnosis; Molecular and immunological techniques; Biochemical tests; PCR; ELISA; Agglutination test.
Unit –V	**Fish Processing Technology**: Studies on physical, chemical and sensory changes-Filleting of fish, treatments, glazing, packaging, freezing, Processing of Prawns, Lobster, Squid, Cuttle Fish, Crab etc. in different styles, Packaging and Freezing, Freezing curve, determination of freezing point.

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Outcomes

- Acquire practical skill on the identification of cultivable finfish and shellfish, fish breeding, ability to construct aquarium, and various processing techniques
- Student will critically discuss the techniques for disease diagnosis

SEMESTER -III Discipline Specific Elective			
Course Code: 547503	**Fish Nutrition and Feed Technology**	**Credits: 4**	**Hours/week: 4**

Objective

- To study the fish nutrition and bioenergetics
- To study the fish feed formulation and processing

Unit –I	**Fish nutrition and biochemistry:** Principles of fish nutrition and terminologies. Nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults. Sources and role of nutrient in physiology of fin and shellfish- Proteins, amino acids, lipids and fatty acids, carbohydrates – carotenoids, vitamins and minerals.
Unit –II	**Nutritional bioenergetics:** Energy requirement of cultivable Finfish and Shellfish - protein to energy ratio, digestible energy, nitrogen balance index, protein sparing effect, high energy feeds, isocaloric diets, Optimal foraging theory, Mathematical modeling of ingestion, Metabolic rate, Energy budgets, Energetic efficiency of fish production.
Unit –III	**Raw material:** National and international status – purchase of feed ingredients - logistic management - storage – inventory maintenance - good management practices – fish silage production – alternative ingredients to fish proteins and fatty acids – quality assurances. Major issues during storage and management.
Unit –IV	**Shrimp Feed processing:** National and international status – types of processing – feed formulation and production - Formulation – raw material mixing - Grinding and Pulverizing - Pre-Hydration- Pre-Conditioning- Pellet Milling- Post conditioning- Drying – Cooling – Crumbling – packing - store maintenance – transport - logistic management – HACCP - Good Management practices**.**
Unit –V	**Finfish feed processing:** National and International Status of floating and semi-floating feed - feed formulation and production - Formulation – raw material mixing: Grinding and Pulverizing - Pre-Hydration - Pre-Conditioning - Pelleting and extrusion – Milling - Post conditioning – Drying - Cooling – Crumbling – packing - store maintenance – transport - logistic management, HACCP - Good Management practices**.**

References

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Cyrino, E. P., Bureau, D., Kapoor, B. G. (2008). Feeding and Digestive Functions in Fishes. Science Publ.

Guillame, J., Kaushik, S., Bergot, P., Metallier, R. (2001). Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publ.

Joachim W. Hertramft, Felicitas Piedad – Pascal (2000). Hand Book on Ingredients for Aquaculture Feeds. Kluwer Academic Publishers, London.

National Research Council (1993). Nutrient Requirements of Fish. National Academy Press, Washington.

Robert R. Stickney (2000). Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York.

Sena S. De Silva, Trever A. Anderson (1995). Fish Nutrition in Aquaculture. Chapman & Hall, London.

Wedemeyer, G. (1996). Physiology of Fish in Intensive Culture Systems. Springer US.

Outcomes

- After completion of this course, students can critically discuss the fish nutrition and bioenergetics
- Students can acquire knowledge on fish feed formulation and processing.

SEMESTER -III Discipline Specific Electives			
Course Code: 547503	**Integrated Fish Farming**	**Credits: 4**	**Hours: 4**

Objective

- To impart theoretical Integrated Fish Farming Systems and knowledge on application of new technique in fisheries science

Unit –I	**Types of Culture Systems**: Operational details of monoculture, composite fish culture polyculture in freshwater and coastal aquaculture - running water systems - Integrated farming.
Unit –II	**Agriculture**: Introduction – history - national and international status - different type of crops - farming systems. Suitable agriculture crops for integrated farming - suitable horticulture crop for integrated fish farming. Mushroom cultivation - Suitable species for integrated production system.
Unit –III	**Animal husbandry:** Introduction – history - national and international status - different type of animals for integrated fish arming systems - cattle – goat - piggery and poultry - farming system – problems Epiculture - Sericulture and economics.
Unit –IV	**Integrated fish farming:** Introduction – history - national and international status - a different type of integrated farming system – aquaculture and agriculture – aquaculture - horticulture and cattle farming - aquaculture – poultry – agriculture - epiculture and animals - cost analysis.
Unit –V	**Aquaponics**: National and international status – types of aquaponics – layout and design of different aquaponics system - production of fish and plants - water, feed and health management – cost analysis.

References

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Banerjee, G. C. (2019). A Textbook of Animal Husbandry. 8th Eds. Oxford.

Chandra, P. (2007). Fishery Conservation, Management and Development. SBS Publ.

Mathias, J. S., Charles, A. T., Bootong, H. U. (1998). Integrated fish farming. CRC Press.

Pandey, N., Davendra, S. M. (2008). Integrated Fish Farming. Daya Publ. House.

Pillay, T.V. R., Kutty, M. N. (2012). Aquaculture Principles and Practices. 2nd Eds. Wiley India.

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Somerville, C., Cohen, M., Pantanella, E., Stankus, A., Lovatelli, A. (2014). Small-scale aquaponics food production Integrated fish and plant farming. FAO Fisheries and Aquaculture Technical Paper 589.

Templeton, R. G. (1995). Freshwater fisheries management. 2nd Eds. Wiley-Blackwell.

Tripathi, S. D., Lakra, W.S., Chadha, N. K. (2018). Aquaculture in India. Narendra Publ. House.

Outcomes

- Students can critically discuss the different agriculture and animal husbandry productions
- Students can acquire thorough knowledge on integrated fish farming

NON-MAJOR ELECTIVE COURSES FOR OTHER DEPARTMENTS

<table>
<tr><td colspan="4">Non Major Elective Course - I</td></tr>
<tr><td>Course Code: ……..</td><td>Aquariculture and Live Feed Production</td><td>Credits: 2</td><td>Hours: 3</td></tr>
<tr><td colspan="4">Objective
To impart knowledge on ornamental aquaculture and aquarium keeping commercially important fishes
To teach live feed culture for ornamental fish production</td></tr>
<tr><td>Unit –I</td><td colspan="3">Ornamental fish introduction: History –international and national status. Capture and cultivable ornamental fishery recourses. Commercially important freshwater, brackish water and marine ornamental fishes, shrimps, gastropods etc. Indigenous and Exotic species Aquarium plants. Biology and life cycle of different finfish and shellfish species.</td></tr>
<tr><td>Unit –II</td><td colspan="3">Infrastructure facilities and equipments: Site selection – layout – design –construction - equipments required for freshwater and marine ornamental hatchery and farm production. Aquarium – freshwater and marine aquarium design - different models - aquarium accessories.</td></tr>
<tr><td>Unit –III</td><td colspan="3">Ornamental fish production: Water quality – feed and health management. Arowana – flower horn - koi carp - gold fish - angel – discuss – breeding and faming. Marine Clown Fish, Damsel Fish, Marine Angels, Butterfly Fish etc. - hatchery and farm management – Cold water ornamental fish production.</td></tr>
<tr><td>Unit –IV</td><td colspan="3">Live feed production for aquarium: Phytoplankton and zooplankton production – fresh water and marine species - different media – water quality parameters - feeding and health management.</td></tr>
<tr><td>Unit –V</td><td colspan="3">Marketing: Present status national and international trading for marine and freshwater ornamental fishes. High value freshwater and marine ornamental fishes. The world most beautiful fishes market price and demand and future prospects. MPEDA – regulations for export and import – government subsidies.</td></tr>
<tr><td colspan="4">References
Dick Mills (1987). The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited.
Er Hunnam (1989). The Living Aquariums. NORDBOK.
John Dawes (1995). Live bearing Fishes (A guide to their Aquarium care, Biology and Classification). Cassell Pvt., London.
Sebastian J. Kuravamveli (2002). The Aquarium Handbook. Amity Aquatech Pvt. Ltd., Cochin.
Stephen Spotte (1985). Marine Aquarium Keeping: The Science, Animals, and Art. Wiley-Interscience.
Sundararaj, V., Sathish, J. M. (2005). Tropical marine aquarium. Yegam Publications, Chennai.
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Mathias, J. S., Charles, A.T., Bootong, H. U. (1998). Integrated fish farming. CRC Press.
Ahilan, B., Felix, N., Santhnam, R. (2008). Textbook of Aquariculture. Daya Publ. House.
Halver, J. E., Hardy, R. W. (2002). Fish Nutrition. Academic Press.</td></tr>
<tr><td colspan="4">Outcomes
Students gain in-depth knowledge on freshwater and marine ornamental fish production
Students can design aquarium and understand the market potential of ornamental fishes.</td></tr>
</table>

Non Major Elective Course - II			
Course Code: ……..	**Integrated Fish Farming**	**Credits: 2**	**Hours: 3**
Objective • To impart theoretical Integrated Fish Farming Systems and knowledge on application of new technique in fisheries science			
Unit –I	**Types of Culture Systems**: Operational details of monoculture, composite fish culture polyculture in freshwater and coastal aquaculture - running water systems - Integrated farming.		
Unit –II	**Agriculture**: Introduction – history - national and international status- different type of crops - farming systems. Suitable agriculture crops for integrated farming - suitable horticulture crop for integrated fish farming. Mushroom cultivation - Suitable species for integrated production system.		
Unit –III	**Animal husbandry:** Introduction – history - national and international status - different type of animals for integrated fish arming systems - cattle – goat - piggery and poultry-farming system – problems. Epiculture - Sericulture and economics.		
Unit –IV	**Integrated fish farming:** Introduction – history - national and international status - a different type of integrated farming system – aquaculture and agriculture – aquaculture - horticulture and cattle farming - aquaculture – poultry – agriculture - epiculture and animals - cost analysis.		
Unit –V	**Aquaponics:** National and international status – types of aquaponics – layout and design of different aquaponics system - production of fish and plants - water, feed and health management – cost analysis.		
References Agarwal, V.P. (1999). Recent trends in aquaculture. Publisher Society of Bios. Muzaffarnagar. Banerjee, G. C. (2019). A Textbook of Animal Husbandry. 8th Eds. Oxford. Chandra, P. (2007). Fishery Conservation, Management and Development. SBS Publ. Mathias, J. S., Charles, A.T., Bootong, H.U. (1998). Integrated fish farming. CRC Press. Pandey, N., Davendra, S. M. (2008). Integrated Fish Farming. Daya Publ. House. Pillay, T.V. R., Kutty, M. N. (2012). Aquaculture Principles and Practices. 2nd Eds. Wiley India. Robert R. Stickney (2000). Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York. Somerville, C., Cohen, M., Pantanella, E., Stankus, A., Lovatelli, A. (2014). Small-scale aquaponics food production Integrated fish and plant farming. FAO Fisheries and Aquaculture Technical Paper 589. Templeton, R. G. (1995). Freshwater fisheries management. 2nd Eds. Wiley-Blackwell. Tripathi, S. D., Lakra, W.S., Chadha, N. K. (2018). Aquaculture in India. Narendra Publ. House.			
Outcomes • Students can critically discuss the different agriculture and animal husbandary productions • Students can acquire through knowledge on integrated fish farming			

Non Major Elective Course - III			
Course Code: …….	**Aquatic Ecology and Biodiversity**	**Credits:2**	**Hours: 3**

Objective

- To acquaint the students with the theoretical and practical aspects of the aquatic environment
- To teach the aquatic biodiversity and conservation

Unit –I	**Concepts in aquatic environment**: Aquatic environment/ecosystem – components-structure and functions; Ecological concepts – succession, homeostasis, natality and mortality, r and k selection; Concepts of habitat and ecological niche; carrying capacity.
Unit –II	**Aquatic ecology**: Freshwater, estuarine and marine - Biotic features of a freshwater, ecosystem. Estuarine and marine ecosystem - classifications, biological features of Coral Reefs, Seaweeds, Seagrasses and Mangroves. Deep sea ecosystem and Hydrothermal vent community. Natural resources and their conservation - Satellite mapping.
Unit –III	**Biological Ecosystem**: Environmental factors influencing life in the oceans: Salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Phytoplankton and Zooplankton - interrelationship, Vertical migration of zooplankton, geographical and seasonal variation in plankton production, plankton and fisheries.
Unit –IV	**Bio-geochemical cycle**: Definition, general concept of complete and incomplete bio-geochemical cycles, sedimentary cycles in tropics. Environmental concerns: population explosion, industrialization, urbanization, and natural calamities; Overexploitation of resources; Environmental stresses; Global Warming; Ozone Depletion.
Unit –V	**Biodiversity**: Definition and concept; factors influencing aquatic biodiversity; Types of biodiversity - Species diversity, Genetic Diversity, and Habitat Diversity; Biodiversity indices and their significance; Concepts of Index of Biotic Integrity (IBI); Economic appraisal of biodiversity; Global diversity patterns and loss of biodiversity.

References

Carter, R. W. G. (1998). Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines. Academic Press.

Gabriella Bianchi, Hein R. Skjoldal (2008). The Ecosystem Approach to Fisheries. CABI.

Gene Helfman, Bruce B. Collette, Douglas E. Facey, Brian W. Bowen (2009). The Diversity of Fishes Biology, Evolution, and Ecology. Wiley.

Joseph S. Nelson, Terry C. Grande Mark, Wilson, V. H. (2016). Fishes of the World. 5th Eds. Wiley.

Khanna, D. R. (2005). Aquatic Biodiversity in India The Present Scenario. Daya Publ. House.

Kormondy, E. J. (1986). Concepts of Ecology. Prentice-Hall.

Mamta Rawat, Chandrakasan Sivaperuman, Sumit Dookia (2015). Aquatic Ecosystem: Biodiversity, Ecology and Conservation. Springer India.

Nikolsky, G. V. (2008). The Ecology of Fishes. Academic Press.

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Park, C. C. (1980). Ecology and Environmental Management. Butterworths.

Sakhare, V. B., Jetithor, S. G., Jadhav, S. S. (2018). Biodiversity and Fisheries. Discovery publishing.

Simon, J., Kaiser, M.J., Reynolds, J. D. (2001). Marine Fisheries Ecology. Blackwell.

World Conservation Monitoring Centre (1992). Global Biodiversity: Status of the Earth's Living Resources. Springer, Dordrecht.

Outcomes

- The student proficiently discuss about the aquatic ecosystem and biodiversity of Fishes
- Student can discuss and analyze the fishery diversity and conservation.

CURRICULUM VITAE

Name : **Dr. E. Kannapiran**

Designation : Professor & Head *i/c*,
Controller of Examinations *i/c*

Address : Department of Fisheries Science, Science Campus,
Alagappa University, Karaikudi-630003,
Sivagangai Dt, Tamil Nadu, India

Qualification : M. Sc., M. Phil., and Ph. D. in Marine Biology and Oceanography

Professional experience: 23 years

Area of Research Expertise

- Marine Biology
- Marine Microbiology
- Coral Reef
- Marine Fouling

Awards/ Recognitions

- Distinguished Professor Award for the year of 2019 by DK International Research Foundation, Perambalur

Recent Publications

- Protein leakage induced marine antibiofouling activity of biosynthesized zinc oxide nanoparticles - **Journal of Cluster Science**
- Toxicological evaluation of biosynthesised hematite nanoparticles *in vivo* - **Colloids and Surfaces B: Biointerfaces**
- Antibacterial and cytotoxicity activities of biosynthesized silver oxide (Ag_2O) nanoparticles using *Bacillus paramycoides* - **Journal of Drug Delivery Science and Technology**
- Length-weight relationship of Coral reef-associated fishes from Gulf of Mannar and Palk Bay, Southeast Coast of India - **Journal of Applied Ichthyology**
- Synthesis of *Tragia involucrata* mediated platinum nanoparticles for comprehensive therapeutic applications: Antioxidant, antibacterial and mitochondria-associated apoptosis in HeLa cells - **Process Biochemistry**

Research Projects : 03 completed as PI & Co-PI

Total Publications:

- Research Papers : 58
- Books / Chapters / Monographs / Manuals: 13

CURRICULUM VITAE

Name : **Dr. Rengarajan Jayakumar**
Designation : Principal Scientist & Head In-Charge
Address : Mandapam Regional Centre,
Central Marine Fisheries Research Institute (CMFRI),
Indian Council of Agricultural Research (ICAR),
Marine Fisheries P.O., Mandapam Camp – 623 520,
Tamil Nadu, India
Qualification : M. Sc., Ph. D. in Zoology
Professional experience: 25 years

Area of Research Expertise

- Mariculture
- Finfish Breeding and seed production
- Fish Health Management

Awards/ Recognitions

- Post Doctoral Fellowship, MCD Biology, University of Colorado, Boulder, CO, USA
- Higher Educational Research fellowship (British Council), UK
- Post Doctoral Research Fellowship (DBT), India
- CSIR Senior Research Fellowship
- Indian Medical Association Award
- Jawaharlal Nehru Memorial Fund Award
- Bharathidasan University First Rank in M.Sc.
- State Level Lectureship, Tamil Nadu (SLST)

Recent Publications

- A note on mass mortality of Bloch's gizzard shad at Dhanushkodi lagoon, Tamil Nadu - **ICAR-CMFRI- Marine Fisheries Information Service Technical & Extension Series**
- Survival and growth of juvenile silver pompano *Trachinotus blochii* (Lacepède, 1801) at different salinities in tropical conditions - **Indian Journal of Fisheries**
- Preliminary estimates of potential areas for seaweed farming along the Indian coast - **ICAR-CMFRI- Marine Fisheries Information Service Technical & Extension Series**
- First report of intersex in Cobia, *Rachycentron canadum* reared in Gulf of Mannar, India—A case study - **Aquaculture Reports**
- Assessment of compensatory growth in stunted fingerlings of Snubnose pompano, *Trachinotus blochii* (Lacepede, 1801), in marine conditions - **Aquaculture Research**

Research Projects: (Funded by ICAR, NFDB and DBT): Rs.16.50 Crores- as PI & Co-PI

Total Publications

- Research Papers: 32; Technical Articles: 24; Teaching Manuals/booklets/book chapters: 28

CURRICULUM VITAE

Name : **Dr. T. T. Ajith Kumar**
Designation : Principal Scientist
Address : National Bureau of Fish Genetic Resources
(Indian Council of Agricultural Research),
Canal Ring Road, Dilkusha PO, Lucknow-226002, India
Qualification : M. Sc., Ph. D., in Marine Biology
Professional experience: 25 years

Area of Research Expertise

- Development of hatchery technologies for marine ornamentals
- On farm evaluation of fish genetic resources for conservation aquaculture
- Livelihood development to costal & island community

Awards/ Recognitions

- Best Researcher- Annamalai University 2008 - 2009
- INSA Fellow - 2009
- K. Chidambaram memorial annual award for the contribution to marine ornamental fish breeding - 2011
- Prof. M. Aruchami award for the contribution to aquaculture, Clownfish - Kongu Nadu Arts and Science college, Bharathiar University, Coimbatore - 2016
- Member - Expert committees on Invasive Alien Species and Normally Traded Commodities, N. B. A., Govt. of India 2017 – 2020

Recent Publications

- Two new records of hippolytoid shrimps, *Lysmata hochi* Baeza & Anker, 2008 (Decapoda: Lysmatidae) and *Lysmata amboinensis* (de Man, 1888) from Lakshadweep Islands, India with taxonomic notes - **Zootaxa**
- *Urocaridella arabianensis* n. sp., a new Palaemonid shrimp (Crustacea, Decapoda, Palaemonidae) from Lakshadweep Islands, India with taxonomic comparison on the genus Urocaridella Borradaile, 1915 - **Zootaxa**
- Dried lemon peel enriched diet improves antioxidant activity, immune response and modulates immuno-antioxidant genes in *Labeo rohita* against *Aeromonas sorbia* - **Fish and Shellfish Immunology**
- *Periclimenella agattii* sp. nov., a new Palaemonid shrimp (Crustacea, Decapoda, Palaemonidae) from Lakshadweep Islands, India - **Zootaxa**
- Infestation of bopyrid isopod parasite (Bopyridae) on ‘coral banded boxing’ shrimp *Stenopus hispidus* Olivier, 1811 (Stenopodidae) in the Lakshadweep archipelago - **Current Science**

Total Publications

- Research Papers : 110
- Book Chapters : 25
- Books : 10
- Popular articles : 30

CURRICULUM VITAE

Name : **Dr. M. Arumugam**
Designation : Associate Professor
Address : Faculty of Marine Sciences,
Centre of Advanced study in Marine Biology,
Annamalai University, Parangipettai – 608 502
Tamil Nadu, India
Qualification : M. Sc., M. Phil., Ph. D. in Marine Biology

Professional experience: 15 years

Area of Research Expertise

- Marine natural products
- Drug discovery research

Awards/ Recognitions

- TNASTC Student Fellow (Govt. of Tamilnadu)- 1999
- Junior Research Fellow (MoEn&F, Govt. of India)- 2000-2003
- Senior Research Fellow (MoEn&F)
- DAAD Summer Trainee(Germany)- 2011
- DST Travel Grant Awardee (Govt. of India)- 2011
- NUS Visiting Fellow(Singapore)- 2012
- 'ERASMUS Fellow', Sweden- 2015
- Best Researcher Award, Annamalai University, India – 2016 & 2017

Recent Publications

- Tyrosinase from *Sepiella inermis* (Van Hasselt [Ferussac & d'Orbigny], 1835) and its Phenol Removal Activity - **Nature Environment and Pollution Technology**
- Biomedical Potential of Astaxanthin from Novel Endophytic Pigment Producing Bacteria *Pontibacter korlensis* AG6 - **Waste and Biomass Valorization**
- Anti-cancer Properties of Protein Hydrolysate from the Posterior Salivary Gland of *Amphioctopus membranaceus* (Quoy & Gaimard, 1832) - **International Journal of Peptide Research and Therapeutics**
- *In Vitro* Studies and Characterization of Tissue Protein from Green Mussel, *Perna viridis* (Linnaeus, 1758) for Antioxidant and Antibacterial Potential - **International Journal of Peptide Research and Therapeutics**
- Formulation of alginate based hydrogel from brown seaweed, *Turbinaria conoides* for biomedical applications - **Heliyon**

Total Publications:

- Research Papers: 81
- Articles and Proceedings: 30

CURRICULUM VITAE

Name : **Dr. A. Gopalakrishnan**
Designation : Assistant Professor
Address : Faculty of Marine Sciences,
Centre of Advanced study in Marine Biology,
Annamalai University, Parangipettai – 608 502
Tamil Nadu, India

Qualification : M. Sc. (Environ. Toxicol.), M.Sc., and Ph. D. in Coastal Aquaculture

Professional experience: 27 years

Area of Research Expertise

- Castrating parasites of fin and shellfishes of Bay of Bengal: Epidemiology, morbidity and effect on host fecundity.
- Taxonomy and epidemiology of Pathogenic viruses and fungi of fin and shellfishes along the Coromandel Coast.
- Participatory fishery resource mapping and fish calendar to enhance the livelihood security of Irula tribal fishes of Vellar-Pichavaram-Coleroon backwater ecosystem.
- Livelihood enhancement of Sc and St and under privileged sections of the Community through Aquaculture activities in Orissa and Tamil Nadu States.
- Biological management of water hyacinth by weevil and Grass carp.
- Ecological, economical and livelihood habitation of tsunami affected Tamilnadu and Pondicherry coastal villages.
- Livelihood rehabilitation of tsunami hit villages Nagapattinam and Cuddalore districts of Tamil Nadu

Recent Publications

- First report of pedunculate barnacle (*Octolasmis neptuni*), as potential asymptomatic carrier of white spot syndrome virus (WSSV) - **Comparative Clinical Pathology**
- *Photobacterium damselae* subsp. damselae associated with bacterial myonecrosis and hepatopancreatic necrosis in broodstock Pacific white leg shrimp, *Litopenaeus vannamei* (Boone, 1931) - **Aquaculture International**
- Occurrence and pathological studies on acanthocephalan (*Neoechinorhynchus agili*) infestation in fishes from Tamil Nadu, South- east coast of India - **Journal of Fisheries and Life Sciences**
- Mandibular Odontogenic Fibrosarcoma in Pickhandle Barracuda (*Sphyraena jello* Cuvier, 1829) - **Thalassas: An International Journal of Marine Sciences**
- Lernanthropids (Copepoda: Siphonostomatoida), Parasitic on Fishes from Southeast Coast of India - **Indian Journal of Geo-Marine Sciences**

Research and Consultancy Projects: Ongoing &Completed: 12

Total Publications: 60

CURRICULUM VITAE

Name : **Dr. N. M. Prabhu**
Designation : Assistant Professor
Address : Disease control and prevention lab,
Department of Animal Health and Management,
Alagappa University, Karaikudi-630003, Tamil Nadu
Qualification : M. Sc. (Coastal Aquaculture), Ph. D. in Marine Biology
Teaching Experience: 13+ Years; **Research Experience**: 20 Years

Area of Research Expertise

- Isolation of bioactive compounds herbal plants and marine seaweeds for anticancer properties.
- Isolation of therapeutic potential sulfated polysaccharides from seaweeds.
- Control and prevention of bacterial pathogens using plant compounds, probiotics and nanoparticles

Awards/ Recognitions

- Best Research award –Alagappa University -2019
- 2006 to 2008, Approved Sea food technologist
- 2003 to 2005, Found a new method of brood collection to reduce the virulence of virus like WSSV, MBV, YHV worked in collaborated project (Water base India Ltd tie up with INVA and Monotech, USA).
- 2000 to 2003 standardized the Soft Shell Mud Crab production for commercialization and exported to Handy International, USA.
- 1999 to 2000, Found a new method for culturing the Soft Shell Mud crab first people in India – The Water base India Ltd
- 1995 to 1997, Project fellow – Shrimp spawner development for Hatchery purposes approved by Tamilnadu state council for science and technology.
- 1994, Project fellow - M/S Sriram Marine Harvest Ltd, Poompuhar (400 ha)

Recent Publications

- Surveillance of disease incidence in shrimp farms located in the east coastal region of India and in vitro antibacterial efficacy of probiotics against *Vibrio parahaemolyticus*-**Journal of Invertebrate Pathology**
- Isolation and structural characterization of sulfated polysaccharide from *Spirulina platensis* and its bioactive potential: *In vitro* antioxidant, antibacterial activity and Zebrafish growth and reproductive performance. **International journal of biological macromolecules.**
- Antibacterial efficacy of a fucoidan fraction (Fu-F2) extracted from *Sargassumpolycystum*– **International Journal of Biological Macromolecules**
- Synthesis, characterization, anti-proliferative and wound healing activities of silver nanoparticles synthesized from *Caulerpascalpelliformis*– **Process Biochemistry**
- Studies on structural properties and immune-enhancing activities of glycomannans from *Schizophyllum commune*– **Carbohydrate Polymers**

Total Publications: 73 **Projects:** Completed -7 As PI & Co-PI

CURRICULUM VITAE

Name : M**r. P. K. Senthil Kumar**

Designation : Chief – Projects

Address : Poseidon Biotech,
No.2,3, PKM cross street, Padasalai road,
Mel Ayanampakkam,Chennai - 600 095, Tamil Nadu

Qualification : M. Sc. in Coastal Aquaculture

Professional experience: 27 years

P. K. Senthil Kumar graduated in Zoology from Bharathiyar University (1988 - 1991) and obtained a post graduate degree in Coastal Aquaculture (1991 - 1993) from CAS in Marine Biology, Annamalai University. He joined the shrimp industry soon after, as a Shrimp Hatchery Technician with S & S Industries & Enterprises Ltd., where he worked for two years. In 1995, he became a part of The Poseidon Group right from its inception, and never looked back. He coordinated various hatchery and lab operations for the company in India, Iran, and Sri Lanka. He was deputed for a brief stint to Vietnam (Minh Phu Seacorp) where he conducted product trials. He has since risen to the post of Chief – Projects and is an integral part of Poseidon Biotech, supporting production and marketing teams apart from being in charge of new projects.

A founder member of Society of Aquaculture Professionals (SAP), Senthil has been the organizer behind SAP events right from inception, as an Event Coordinator. He became the SAP Coordinator in 2009 and has worked closely with the different SAP Executive Committees towards planning and executing the organizational duties of the association. He has been the event manager for all our Aqua India programs and has worked tirelessly for its smooth and efficient operation. He served SAP as an EC Member from 2008-2014, as Treasurer from 2014-2018 and is its Joint Secretary from 2018 onwards.