AnnamalaiUniversity
(Accredited with 'A' Grade by NAAC)

B.VOC (AQUACULTURE)

(Three – Year) Programme

Regulations & Curriculum

2019-2022

CAS in Marine Biology
FACULTY OF MARINE SCIENCES

ANNAMALAIUNIVERSITY

REGULATIONS FOR THE THREE-YEAR UNDER GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Academic regulations shall be called Annamalai University, Faculty of Marine Sciences "B.Voc Academic Regulations 2019" for obtaining Bachelor's Degree in the Faculty of Marine Sciences. These Regulations are common to all the students admitted to the Three-Year Bachelor's Programme in the Faculty of Marine Sciences from the academic year 2019-2022 onwards.

1. Definitions and Nomenclature

1.1 University refers to Annamalai University.

1.2 Department means any of the academic departments and academic centres at the University.

1.3 Discipline refers to the specialization or branch of knowledge taught and researched in the Marine Sciences.

1.4 Programmeencompasses the combination of courses and/or requirements leading to a Degree. For example, B.Voc, B.Sc., B.A

1.5 Course is an individual subject in a Programme. Each course may consist of Lectures/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 Curriculum encompasses the totality of student experiences that occur during the educational process.

1.7 Syllabus is an academic document that contains the complete information about an academic Programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 Academic Year refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 Semester is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 Choice Based Credit System A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree Programme.

1.11 Core Course is mandatory and an essential requirement to qualify for the Degree.

1.12 Elective Course is a course that a student can choose from a range of alternatives.

1.13 Value-added Courses are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 Credit refers to the quantum of course work in terms of number of class hours in a semester required for a Programme. The Credit value reflects the content and duration of a particular course in the curriculum.

1.15 Credit Hour refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular class.

1.16 Programme Outcomes (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a Programme.

1.17 Programme Specific Outcomes (PSOs) are statements that list what the graduate of a specific Programme should be able to do at the end of the Programme.

1.18 Learning Objectives also known as Course Objectives are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

1.19 Course Outcomes (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 Grade Point Average (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 Cumulative Grade Point Average (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

1.22 Letter Grade isan index of the performance of a student in a particular course. Grades are denoted by letters S, A, B, C, D, E, RA, and W.

2. Programmes Offered and Eligibility Criteria

Faculty of Marine Sciences	
B.Voc Aquaculture	A pass in HSC (Academic) / HSC (Vocational) from Tamilnadu state board or its equivalent thereto.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for the above Programme.

3. Reservation Policy

Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Three Year Undergraduate Programme consist of three academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Three Year UndergraduateProgramme consists of Core Courses, Elective Courses (Departmental & Interdepartmental) and Project.

5.2 Core courses

5.2.1. These are a set of compulsory courses essential for each Programme.

5.2.2. The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 **Department Electives (DEs)** are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2**Interdepartmental Electives (IDEs)** are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.3.3 **Each student shall take a combination of both DEs and IDEs.**

5.4 Experimental Learning

5.4.1 Experimental Learning provides opportunities to students to connect principles of the discipline with real-life situation.

5.4.2 In-plant training / field trips / internships / industrial visits 3as applicable) fall under this category

5.4.3 Experimental learning is categorized as core

5.5 Project

5.5.1 Each student shall undertake a Project in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the University website and in the Handbook on Interdepartmental Electives and VACs.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.6.4 Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

5.7 Online Courses

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 Credit Distribution

The credit distribution is organised as follows:

	Credits
Core Courses	65-75
Elective courses	24
Project	12
Total (Minimum requirement for award of Degree)	**90-95***

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 90-95 credits.*

5.9 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of *Attendance and Assessment Record* for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course Instructor.

6.3 The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student should have at least 75% attendance in the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic Programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations, attend campus interviews and participate in extra-curricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class test, assignment, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment and the procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test – I will cover the syllabus of the first two Units while CIA Test – II will cover the last three Units.

8.4.5 CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6. A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first/third semester will be conducted in November and for the second/fourth semester in May.

8.5.2 A candidate who does not pass the examination in any courses of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1. Each course, both Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will constitute 40% and the ESE 60% of the marks.

9.2. Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test – I	10
Test – II	10
Seminar	03

Assignment	02
Total	25

9.2.3For the Practical Courses wherever applicable), the break-up of marks shall be as follows:

	Marks
Test – I	15
Test – II	15
Viva-voce and Record	10
Total	40

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by both External and Internal examiners (Double Evaluation).

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and Viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project evaluation Committee will comprise the Head of the Department, Project Supervisor and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (30 Marks)		End Semester Examination (70 Marks)			
		Thesis Evaluation (40)		Viva-voce (30)	
Review-I 15	Review-II: 15	Internal	External	Internal	External
		20	20	15	15

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal.

9.5.2 Two CIA Tests shall be conducted during the semester by the Departments offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Bachelor's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the Programme and earned the minimum required credits shall be considered to have passed the Bachelor's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed from the first semester to the current semester.

11.3 The GPA is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

Where 'C_i' is the Credit earned for the Course i in any semester;

'G_i' is the Grade Point obtained by the student for the Course i and

'n' is the number of Courses passedin that semester.

11.4. CGPA is the weighted average Grade Point of all the Courses passed starting from the first semester to the current semester.

Where GG is the Credit earned for the course G in any semester

GG is the Grade point obtained by the student for the Course G

G is the number of courses passed in that semester

G is the number of semesters

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

Letter Grade	Grade Points	Marks %
S	10	90 and above
A	9	80-89
B	8	70-79
C	7	60-69
D	6	55-59
E	5	50-54
RA	0	Less than 50
W	0	Withdrawn from the examination

11.6 Classification of Results. The successful candidates are classified as follows:

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme*in the first attempt* with a CGPA of 8.25 or above within

the Programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details)

11.6.2 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5

11.6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.7 Course-Wise Letter Grades

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in **ANY ONE** of the semesters **ONLY** for exigencies deemed valid by the University authorities.

12.3. Permission to withdrawal from the examination shall be granted only once during the entire duration of the Programme.

12.4. Application for withdrawal shall be considered **only** if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5. The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal is **not** granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First class with Distinction.

13.Academic misconduct

Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitised on issues of academic integrity and ethics.

14. Transitory Regulations

Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted three consecutive times after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two year Master's Programme at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendation of the Academic Council.

AnnamalaiUniversity

Centre of Advanced Study in Marine Biology

B. Voc. Aquaculture (Three Year) Programme

Programme Structure

(For students admitted from the academic year 2019-2022)

FIRST YEAR -FIRST SEMESTER

Code	Subjects	Period / Week			Exam Duration	Marks		Total Marks	Credits
		L	T	P		CA	FE		
AQCC 101	Communicative English	3	0	0	3	25	75	100	3
AQCC 102	Life coping skill	3	0	0	3	25	75	100	3
AQCC 103	Introduction to Computer	3	0	0	3	25	75	100	3
AQCC 104	Biology of cultivable shell and fin fishes	4	0	0	4	25	75	100	4
AQCC 105	Principles and Methods in Aquaculture	3	0	0	3	25	75	100	3
AQCP 106	Practical I (Covering course AQCC 101&102)	0	0	3	3	40	60	100	2
AQCP 107	Practical II (Covering course AQCC 103)	0	0	3	3	40	60	100	2
AQCP 108	Practical III (Covering course AQCC 104)	0	0	3	3	40	60	100	2
AQCP 109	Practical IV (Covering course AQCC 105)	0	0	3	3	40	60	100	2
AQCT 110	Apprenticeship/ training	0	0	6	3	40	60	100	6
	Total credit	16	0	18		325	675	1000	30

[L]-Lecture [T] -Theory [P] – Practical [CA] - Continuous Assessment [FE] - Final Examination

FIRST YEAR -SECOND SEMESTER

Code	Subjects	Period. Week			Exam Duration	Marks		Total Marks	Credits
		L	T	P		CA	FE		
AQCC 201	Soft Skill & Personality development	3	0	0	3	25	75	100	3
AQCC 202	Brackish water Aquaculture and Mariculture	4	0	0	3	25	75	100	4
AQCC 203	Hatchery Technology in Aquatic organisms	3	0	0	3	25	75	100	3
AQCC 204	Freshwater aquaculture	3	0	0	3	25	75	100	3
AQCC 205	Culture of Live fish Food Organisms	3	0	0	3	25	75	100	3
AQCP 206	Practical V (Covering course AQCC 201)	0	0	3	3	40	60	100	2
AQCP 207	Practical VI (Covering course AQCC 202)	0	0	3	3	40	60	100	2
AQCP 208	Practical VII (Covering course AQCC 203)	0	0	3	3	40	60	100	2
AQCP 209	Practical VIII (Covering course AQCC 204)	0	0	3	3	40	60	100	2
AQCT 210	Apprenticeship/ training	0	0	6	3	40	60	100	6
	Total credit	16	0	18		325	675	1000	30

SECOND YEAR -THIRD SEMESTER

Code	Subjects	Period / Week			Exam Duration	Marks		Total Marks	Credits
		L	T	P		CA	FE		
AQCC 301	Disaster Management	3	0	0	3	25	75	100	3
AQCC 302	Aquaculture Nutrition and Feed Management	4	0	0	3	25	75	100	4
AQCC 303	Inland and Marine Fisheries	3	0	0	3	25	75	100	3
AQCC 304	Aquatic Ecology and Biodiversity	3	0	0	3	25	75	100	3
AQCC 305	Soil and Water Quality management	3	0	0	3	25	75	100	3
AQCP 306	Practical IX (Covering course AQCC 302)	0	0	3	3	40	60	100	2
AQCP 307	Practical X (Covering course AQCC 303)	0	0	3	3	40	60	100	2
AQCP 308	Practical XI (Covering course AQCC 304)	0	0	3	3	40	60	100	2
AQCP 309	Practical XII(Covering course AQCC 305)	0	0	3	3	40	60	100	2
AQCT 310	Apprenticeship/ training	0	0	6	3	40	60	100	6
	Total credit	16	0	18		325	675	1000	30

SECOND YEAR -FOURTH SEMESTER

Code	Subjects	Period / Week			Exam Duration	Marks		Total Marks	Credits
		L	T	P		CA	FE		
AQCC 401	Entrepreneurship	3	0	0	3	25	`75	100	3
AQCC 401	Genetics and Biotechnology	3	0	0	3	25	75	100	3
AQCC 403	Pathology in Aquaculture	4	0	0	3	25	75	100	4
AQCC 404	Fish Processing Technology and Quality Control	3	0	0	3	25	75	100	3
AQCC 405	Anatomy of Finfish and Shellfish	3	0	0	3	25	75	100	3
AQCP 406	Practical XIII (Covering course AQCC 402)	0	0	3	3	40	60	100	2
AQCP 407	Practical XIV (Covering course AQCC 403)	0	0	3	3	40	60	100	2
AQCP 408	Practical XV (Covering course AQCC 404)	0	0	3	3	40	60	100	2
AQCP 409	Practical XVI (Covering course AQCC 405)	0	0	3	3	40	60	100	2
AQCT 410	Apprenticeship/ training	0	0	6	3	40	60	100	6
	Total credit	16	0	18		325	675	1000	30

THIRD YEAR –FIFTH SEMESTER

Code	Subjects	Period / Week			Exam Duration	Marks		Total Marks	Credits
		L	T	P		CA	FE		
AQCC 501	Limnology	3	0	0	3	25	`75	100	3
AQCC 502	Molluscs and Seaweed culture	3	0	0	3	25	75	100	3
AQCC 503	Aquaculture Engineering	4	0	0	3	25	75	100	4
AQCC 504	Elective-1	3	0	0	3	25	75	100	3
AQCC 505	Elective -2	3	0	0	3	25	75	100	3
AQCP 506	Practical XVII (Covering course AQCC 501)	0	0	3	3	40	60	100	2
AQCP 507	Practical XVIII (Covering course AQCC 502)	0	0	3	3	40	60	100	2
AQCP 508	Practical XIX (Covering course AQCC 503)	0	0	3	3	40	60	100	2
AQCP 509	Practical XX (Covering course AQCC 504 & 505)	0	0	3	3	40	60	100	2
AQCT 510	Apprenticeship/ training	0	0	6	3	40	60	100	6
	Total credit	16	0	18		325	675	1000	30

Electives:

1. **Fish Immunology**
2. **Marine Biology**
3. **Aquaculture in Reservoir**

THIRD YEAR –SIXTH SEMESTER

Code	Subjects	Period / Week			Exam Duration	Marks		Total Marks	Credits
		L	T	P		CA	FE		
AQCC 601	Ornamental Fish Breeding and Culture	3	0	0	3	25	`75	100	3
AQCC 602	Aquaculture Extension and Economics	4	0	0	3	25	75	100	3
AQCC 603	Elective -1	3	0	0	3	25	75	100	3
AQCC 604	Elective-2	3	0	0	3	25	75	100	3
AQCC 605	Practical XXI (Covering course AQCC 601)	0	0	3	3	40	60	100	2
AQCC 606	Practical XXII (Covering course AQCC 602)	0	0	3	3	40	60	100	2
AQCP 607	Practical XXIII (Covering course AQCC 603 & 604)	0	0	3	3	40	60	100	2
AQCP 608	Project	0	0	6	3	40	60	100	12
	Total credit	16	0	18		325	675	1000	30

Elective Subjects:

1. **Fish Microbiology and Quality Assurance**
2. **Disease Management in Aquaculture**
3. **Fish Preservation Technology**

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.

Elective Courses

Department Electives (DE)

S.No.	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
1.	Fish Immunology	3		3	25	75	100
2.	Marine Biology	3		3	25	75	100
3.	Aquaculture in Reservoir	3		3	25	75	100
4.	Fish Microbiology and Quality Assurance	3		3	25	75	100
5.	Disease Management in Aquaculture	3		3	25	75	100
6.	Fish Preservation Technology	3		3	25	75	100

Inter Departmental Electives (IDE)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
AQCC 101	Communicative English	3		3	25	75	100
AQCC 102	Life Coping Skills	3		3	25	75	100
AQCC 103	Introduction to Computers	3		3	25	75	100
AQCC 201	Soft Skill & Personality Development	3		3	25	75	100

Programme Outcomes

PO1:	The Faculty of Marine Sciences will endeavor to continue a world class Bachelor vocational program in Aquaculture with experts in the subject areas being taught, including the recent research areas and are passionate when working with students in undergraduate and post graduate levels.
PO2:	The Marine Science faculty will continue to review, update and revise the curriculum to ensure the quality of syllabus in commendable level.
PO3:	Students graduating with a Bachelor degree in Aquaculture should be skilled in the advance level of marine sciences.
PO4:	Students graduating with a Bachelor degree in Aquaculture will be trained to involve in higher education and other job opportunities.
PO5:	Students graduating in Aquaculture with bachelor level dissertation work/pre research experience will ensure their future become a good Researcher and also Field Experts.

Programme Specific Outcomes

At the end of the Programme, the student will be able to

PSO1:	Impart the complete knowledge about the fundamentals of Marine Sciences including the Farm Engineering, Biology of Cultivable Species and Marketing techniques.
PSO2:	Explore the basics of Marine Biology along with aquaculture and also Disease management in Aquaculture, Fish Processing Technology.
PSO3:	Taught the Hatchery Technology in Aquaculture, Aquatic organisms in both Fresh and Marine Water, Culture of Live Fish food organisms and also Feed Management in Aquaculture.
PSO4:	Gain the knowledge about the taxonomy of marine organisms by using the conventional method and advanced level of molecular methods.
PSO5:	Prepare the students not only the biological information and train the various techniques/instruments viz., Samplers, different nets, Soil Sampler, pH meter, DO meter,Seichi disc, Spectrometer, Gel Doc, HPLC, FTIR etc.
PSO6:	Carry out the various experiments for water quality,enumerate the primary producers, different disease diagnostic techniques in Aquaculture, different types of feed and their palatability tests, probe development and microbial identification.
PSO7:	Practice the students with proficient in culture of marine organisms, utilization of marine resources to make as an entrepreneur and also to learn about Food technology aspects.

Semester I **AQCC 101 COMMUNICATIVE ENGLISH**

Credits: 3
Hours: 3

Course Objectives

- **To enhance communications skill of the learners**
- **To familiarize the essay writing and the construction of sentences**
- **To enhance capacity of the students on the letter writing skill**

Learning Outcomes

- ✓ **Communicative skills enhancement in real life situations.**
- ✓ **Students will equip with oral communication skills**
- ✓ **Communicative English in general will support the students with basic communication.**

UNIT I READING

Definition of reading, Levels of reading- Requirements of Reading-Types of Reading-Techniques of reading- Academic reading tips- Exercise.

UNIT II WRITING

The sentence, The Phrase, Kinds of Sentences, Parts of Sentence, Parts of speech, Articles-Types of Sentence, Time Management Tips-Test Preparation Tips, Tips forTaking Exams-Construction of Paragraph, Linkage and Cohesion-Academic Essay Writing-Thesis-Report Abstracts-Letter Writing-Memo, Cover Letter, Resume Writing- Exercise.

UNIT III LISTENING SKILLS

Types of Listening- Objectives- Active Listening- an Effective Listening Skill- Note Taking Tips- Barriers for Good Listening. Purpose of Listening, Outlines and Signposting-Gambits-Exercise.

UNIT IV COMMUNICATION SKILLS

Communication Skills- Speaking Skills, Definition-Barriers of Communication- Types of Communication- Exercise.

UNIT V APTITUDE

Verbal and Numerical aptitude- Notes to be made from listening short lectures. Adapting to corporate life- Corporate Etiquette- Grooming and Dressing- Organizing and Attending Meetings- Facing Interviews.

TEXT BOOKS

1. **Edgar Thorpe. 'Course in Mental Ability and Quantitative Aptitude', Tata McCraw Hill, 2003**
2. **Edgar Thorpe. 'Test of Reasoning', Tata McGraw-Hill, 20**
3. **Lala S. Pusho. H. P and Sanjay Kumar. Communicate or collapse: a handbook of effective public speaking, group discussions and interview'. PHI Learning Pvt. Ltd., 2007**

REFERENCE BOOK

1. **Department of Humanities and social sciences, Anna University, 'English for Engineers and technologies' Volume I & II (combined edition), Orient Longman Pvt Ltd., 2006.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the definition of Reading, Different techniques in Reading, Levels of Reading and also Academic Reading.
CO2:	To understand the Listening skills – Barriers to Listening, Signposting, Gambits.
CO3:	To understand the different tips of writing like Essay writing, Thesis writing, Abstract writing, and also Linkage and Cohesion.
CO4:	To understand the communication skills i.e. Speaking, different barriers of Speaking.
CO5:	To understand the different Numerical and Verbal Aptitude. Grooming and Dressing – Attending meeting and how to face interviews.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**3**		**3**	**3**		**3**	**3**	**3**		**3**	**3**	
CO2	**3**		**3**			**3**	**3**	**3**		**3**	**3**	
CO3	**3**		**3**		**3**	**3**	**3**		**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	**15**	**15**	**9**	**9**	**15**	**15**	**9**

Semester I **AQCC 102 LIFE COPING SKILL**

Credits: 3
Hours: 3

Course objectives

- **To induce motivation, self-esteem and leadership quality among the learner.**
- **To enhance the individuals to set goals and handle depression, fear and failures.**
- **To develop an individual's personality there by making them optimist.**

Learning outcomes

- ✓ **This study by the end will raise students with good leadership qualities.**
- ✓ **It increases positive thinking and strength in handling fear and failure**
- ✓ **The person comes out with a strong vision towards life with a good personality.**

UNIT I SELF ESTEEM AND PERSONALITY DEVELOPMENT

Self-esteem-importance of self-esteem- positive self-development- self acceptance of strengths and weakness- personality development- methods- do's and don'ts-skills to develop.

UNIT II POSITIVE THINKING

Right perception of life- emphasize good things- transform from soft to tough minded individuals- weak to strong men/women

UNIT III MOTIVATION AND GOAL SETTING

Concept of motivation-energizing and directing efforts for goal- enhance motivation desires and aspirations- different types of goals- importance of pursuit of personal goals setting, goals- striving for goals

UNIT IV COPING WITH DEPRESSION, FEAR AND FAILURE

Depression-nature-symptoms and causes- ways to overcome depression- types of failure-understanding failures- handling fear-overcoming failure and fear- understanding anger-hindering anger to achieve goals- coping with failures

UNIT V LEADERSHIP

Leadership- Nature and types- characteristics of good leadership- leadership role courage and confidence.

TEXT BOOK

1. **Alphonse, S.J. Xavier,' We shall overcome' ICRDCE publication, Chennai. 5th edition,2011.**

REFERENCE BOOKS

1. **Dale Carnegie, "The Leader in You", Simon, 2012**
2. **Robert Heller, "Effective Leadership (Essential Managers)", Dorling Kindersley, 2011**
3. **Stephen R Covey, "The Seven Habit of Highly Effective People", Kindle, 2015.**

Course Outcomes
At the end of the course, the student will be able to

CO1:	To understand the Self Esteem and Personality development Strengths and Weaknesses. Dos and Don'ts to Develop.
CO2:	To understand the perception of life transforming from soft to tough mind and also Weak to Strong men/women.
CO3:	To understand the Concept of goals, goals setting and striving for goals.
CO4:	To understand how to cope with depression, fear and failure.
CO5:	To understand the leadership qualities and the courage of a good leader.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3	3	3	3		
CO2	3	3	3	3					3	3		
CO3	3	3	3	3		3				3	3	3
CO4	3	3	3	3	3	3	3	3		3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3		
CO2				3	3		
CO3	3				3	3	3
CO4	3	3	3		3	3	3
CO5	3	3	3	3	3	3	
Total	12	9	9	9	15	09	06

Semester I **AQCC 103 INTRODUCTION TO COMPUTER**

Credits: 3
Hours: 3

Course Objective

- **To familiarize the students with Fundamentals of Computer and IT applications**
- **To expose the students to various operating systems and its working.**
- **To enlighten the students on basic technological tools used related to biology.**

Learning Outcomes

- ✓ **Students enhance their programming fundamentals**
- ✓ **Familiarizing with MS Office**
- ✓ **Handle various trends in computer communication**

UNIT I INTRODUCTION TO COMPUTERS

Classification, History, Types of Computers. Elements of a Computer System: Block Diagram of the Computer System, Introduction to various units. Hardware: CPU, Memory, Input and Output devices, Auxiliary storage devices. Software: System and Application Software, Utility packages, configuration of Computer System Applications of Information Technology: Wide range of applications in: Home, Education and Training, Entertainment, Science, Medicine, Engineering etc.

UNIT II COMPUTER ACCESSORIES

Input Devices: Mouse, Keyboard, Light pen, Track Ball, Joystick, MICR, Optical Mark reader and Optical Character reader. Scanners, Voice system, Web, Camera.

Output Devices: Hard Copy Output Devices; Line Printers, Character Printers, Chain Printers, Dot-matrix Printers, Daisy Wheel Printer, Laser Printers, Ink jet Printers, Plotters, Soft Copy device-Monitor, Sound card and speakers.

Memory and Mass Storage Devices; Characteristics of Memory Systems; Memory Hierarchy; Types of Primary Memory; RAM and ROM; Secondary and Back-up; Magnetic Disks, Characteristics and classification of Magnetic Disk, Optical Disk, Magnetic Tape.

UNIT III MS WORD

Documentation Using MS-Word -Introduction to Office Automation, Creating & Editing Document, Formatting Document, Auto -text, Autocorrect, Spelling and Grammar Tool, Document Dictionary, Page Formatting, Bookmark, Advance Features of MS-Word- Mail Merge, Macros, Tables, File Management, Printing, Styles, linking and embedding object, Template.

UNIT IV MS EXCEL & POWER POINT

Electronic Spread Sheet using MS-Excel -Introduction to MS-Excel, Creating & Editing Worksheet, Formatting and Essential Operations, Formulas and Functions, Charts, Advance features of MS-Excel -Pivot table & Pivot Chart, Linking and Consolidation.

Presentation using MS-PowerPoint: Presentations, Creating, Manipulating & Enhancing Slides, Organizational Charts, Excel Charts, Word Art, Layering art Objects, Animations and Sounds, Inserting Animated Pictures or Accessing through Object, Inserting Recorded Sound Effect or In-Built Sound Effect.

UNIT V COMPUTER COMMUNICATIONS

Introduction, Objectives. Basic of Computer Networks: Local Area Network (LAN), Wide Area Network (WAN). Internet: Concept of Internet, Applications of Internet, Connecting to the Internet, Troubleshooting, World Wide Web (WWW), Web Browsing Software, Popular Web Browsing Software.

Basics of E - mail: What is an Electronic Mail, Email Addressing, Using E - mails: Opening Email account, Mailbox: Inbox and Outbox, Creating and Sending a new E - mail, Replying to an E - mail message, forwarding an E - mail message, Sorting and Searching emails.

TEXT BOOKS

1. **Sinha, P.K. and Priti Sinha, "Computer Fundamentals", BPB, 2016**
2. **Steven Weikler, Office 2017 for the Begineers, Kindle Publication, 2016**

REFERENCE BOOKS

1. **Bokhari and Ahmad 'UNIX Operating System', Dhanpat Rai & Co, 2004.**
2. **Sathish Jain, Kratika and Geetha M, "Office 2010 Course Complete Book for Learning Better and Faster", BPB, 2016.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Basics of Computers like Introduction to computers, Input and Output devices, Applications of Computers.
CO2:	To understand the techniques of MS Word Creating and Editing Document and also different shortcuts, Mail merge, Macros etc.
CO3:	To understand the MS Excel and MS Power point i.e. different formulas in Excel and also creating tables, and also slide presentation.
CO4:	To understand the different accessories used in computers i.e. Light pen, Mouse etc.
CO5:	To understand the communication in Computers LAN, WAN, MAN and also Internet, E-mail.

Course Outcomes

At the end of the course, the student will be able to

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3				
CO3	3		3		3	3	3		3			3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3				
CO3	3	3		3			3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	15	15	09	09	09	09	09

Semester I AQCC 104 BIOLOGY OF CULTIVABLE SHELL AND FIN FISHES

Credits: 3
Hours: 3

Course Objectives

- **Ensure active student participation in activities connected with basic aquaculture practices.**

- **Provide basic understanding of biological, chemical and environmental concepts pertaining to aquatic environment.**
- **Acquaint students with various fisheries institutions and their activities.**

Learning Outcomes

- ✓ **At the end of the study students will be equipped with basic aquacultural practices.**
- ✓ **Acquire clear knowledge about the taxonomy of the cultivable fishes**
- ✓ **Knowledge on the biology and feeding habits of the species would be learnt by the students**

UNIT I GENERAL CHARACTERISTICS AND TAXONOMY OF FISHES

Principles of Zoological classifications, binomial nomenclature and linear hierarchy.Classification of commercially important fishes, crustaceans and mollusks.General characters of fishes, crustaceans and mollusks. Sense organs in lorenzini etc. sound production in fishes. Specialized organs in fishes - electrical organs, venom and toxins in fishes.Coloration and Bioluminescence in fishes.Sense organs in crustaceans and mollusks.Buoyancy in fishes-swim bladder and mechanism of gas secretion.

UNIT II FEEDING AND GROWTH

Feed and feeding habits – herbivores, carnivores and omnivores. Feeding adaptations methods employed in the study of gut content analysis volumetric, gravimetric etc. Age and growth – Techniques used in the study- use of scales and otoliths, length frequency analysis.Length weight relationship. Equations used for deriving growth rates.

UNIT III DIGESTION, RESPIRATION AND CIRCULATION

Digestive system – General morphological feature of digestive system in fishes, Digestive system and process of digestion in prawn and mussel.(Type – Mullet, *P.monodon*, Fresh water Mussel). Respiratory system – general description, aquatic respiration, respiratory gases, gaseous exchange, and oxygen transport (Shark and Mullet). Adaptations for air breathing in fishes.Respiration in crustaceans and molluscs. Cardiovascular system – General features of heart and blood circulation, circulatory system and oxygen transport in fishes' crustaceans and mollusks.

UNIT IV REPRODUCTION

Reproduction – ovary and testes, structure, development of primary and secondary sexual. Sexual dimorphism in fishes and crustaceans.Maturation and spawning in fishes, factors affecting maturation and spawning.Fecundity, condition factor, size at first maturity.Oviparous, viviparous and ovoviviparous fishes.

UNIT V MIGRATION

Parental care and breeding migration in fishes and crustaceans.Migration in fishes – anadromous and catadromous, homing, instinct and orientation.Biological clocks- diurnal, lunar, circadian and tidal rhythms.

TEXT BOOKS

1. **Parker and Haswell. Textbook of zoology, Vertebrates. Vol-II,*publication.* 1897 7thEdition.**
2. **Marshall & Williams. Textbook of Zoology. Vol.I,London: Macmillan, 1972.**

3. **Barnes.R.D. General Zoology- 5th Edition, 1978, From Bibliohound (Carlsbad, CA, U.S.A.)**
4. **S.S. Khanna. An introduction to fishes,Surjeet *Publications* was launched in 1976 by the enterprising Surjeet Singh Chhabra.**
5. **Karl.F. Lagler. Ichthyology-2nd edition, John Wiley & Sons; (1 June 1977)**
6. **Jhingran,V.G. Fish and Fisheries of India, Hindustan *Publishing* Corporation (*India*), 1991.**
7. **Moyle,P.B. and Cech,J.J. Fishes – An Introduction to Ichthyology, 5th Edition, Prentice-Hall, New Jersey, 2004.**
8. **Jhingran, V.G. Fish and fisheries of India. Hindustan Publ. Corporation (India), 1982.**
9. **Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868.**
10. **Chen, T.P., 1976. Aquaculture Practices in Taiwan. Fishing News (Books) Ltd., London, 160.**
11. **Shigueno, K., 1978. Problems in Prawn Culture. Amerind Publishing Co. Pvt. Ltd., New Delhi, 103.**
12. **Josianne., G Stottrup and Lesley A. McEroy, 2003. Live feeds in Marine aquaculture. Published by Wiley- Blackwell, 1st edition.**
13. **David, A. Bengtson, 2003. Status of Marine aquaculture in relation to live prey: past, present and future, Wiley - Blackwell.**
14. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1stedition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Francis Day, The fishes of India, publication info: London B Quaritch, 1876.**
2. **Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Book) Ltd., London, 497.**
3. **Korringa, P., 1976. Farming Marine Fishes and Shrimps. Elsevier Publishing Company, Amsterdam, 208.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the general characters and classification of Fishes, Crustaceans and Molluscs.
CO2:	To understand the different food and feeding habitats, Age and growth determination in Fishes.
CO3:	To understand the different metabolic activities like digestion, respiration and excretion fishes, Crustaceans and Molluscs.
CO4:	To understand the Maturation, Spawning and Fecundity in Fishes.
CO5:	To understand the Parental care, Breeding and Migration in Fishes.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3		3		3		
CO3	3		3		3	3			3			3
CO4	3	3	3	3	3	3	3		3			3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3		3		3		
CO3	3			3			3
CO4	3	3		3			3
CO5	3	3	3	3	3	3	3
Total	15	09	09	09	09	09	09

Semester I AQCC 105 PRINCIPLES AND METHODS IN AQUACULTURE

Credits: 3
Hours: 3

Course Objectives

- **To understand the principles involved in Aquaculture.**
- **To familiarize the various method employed in the field of Aquaculture**
- **Basic knowledge about the pond ecology, types of ponds and Mariculture practices exists both in India and also in the world.**

Learning Outcomes

- ✓ **The learner will gain a thorough knowledge on the principles and methods involved in aquaculture.**
- ✓ **Students will acquire clear knowledge about the methods employed in aquaculture systems**
- ✓ **The controlled ecosystem dynamics would be clear to the students**

UNIT I INTRODUCTION

History, definition, scope and significance of aquaculture, comparison of aquaculture with Agriculture and commercial fisheries.Different aquaculture system.Aquaculture – Global and Indian Scenario.

UNIT II POND ECOLOGY

General concepts of ecology, productivity, carrying capacity, food chain and food web.Ecology of culture ponds. Nutrient cycles--Nitrogen Phosphorous and carbon. Laws of limiting factor.Fertilization and manuring.Liming and application of fertilizers and manures, role of nutrients, the NPK contents of various fertilizers and manures, rate and precautions in the application of fertilizers and manures.Significance and important groups of phytoplankton, zooplankton and benthos in culture ponds.Nutrient dynamics, algal blooms.Selection of site, physic-chemical conditions of soil and water optimum for culture.Management of water and soil quality parameters. Correction of pH, measures for increasing the concentration of oxygen and reducing the concentration of ammonia and hydrogen sulphide.

UNIT III TYPES OF PONDS

Types of ponds – hatching, nursery, rearing, stocking and brood stocks – construction andmanagement of culture system.Size and depth of ponds, maintenance of ponds – positioning of different types of ponds ina fish farm.

UNIT IV CULTIVABLE FRESHWATER FISHES

Criteria for the selection of species.Cultivable freshwater fishes- carps, air breathing fishes, tilapia, freshwater prawn.

UNIT V BRACKISH WATER CULTURE AND MARICULTURE

Brackishwater resources and fishes of commercial importance – Milk fish, mullet, pearl spot, Seabass, shrimps, crabs; selection of site.Major brackish water culture system in India.Different organisms in Mariculture – mussel, edible oyster, pearl oyster and sea weeds.

TEXT BOOKS

1. **Friedrich., H. Marine Biology, published by Sidgewick& Jackson, London, United Kingdom (1969).**

2. **Raymont, J.E.G: Plankton and productivity in the Oceans; published by Pergamon Volume 1- 2nd edition. (1980)**
3. **Balakrishna Nair. N. and D.M. Thampy: A text book of Marine ecology Published by Macmillan in Delhi. (1980)**
4. **Frank. J Millero, 2013, Chemical Oceanography, 4th edition, Published by CRC press.**
5. **Oceanography- Harold V.Thurman, National Geographic *publication-10th edition***
6. **Rath,R.K. Freshwater Aquaculture, published in 2005,Newyork -1972.**
7. **Coastal Fisheries and Aquaculture Management, 2 Vols. K. Gopakumar,A.D. Diwan - Published by Narendra Publishing House, 2011.**
8. **Richard W. von Norman, 1963. Experimental Biology. Prentice – Hall, New York.**
9. **Gunter Zweig and Joseph Sherma, 1972. Handbook of Chromatography Vols. I & II. Cleveland, Ohilo 44128. (317).**
10. **Gabe Manfred, 1976. Histological Techniques. Springer – Verlag, New York.**
11. **Galan W. Ewing, 1985. Instrumental Methods of Chemical Analylsis. McGraw – Hill Book Company, 538.**
12. **Douglas A. Skoog, F. James Holler, Stanley R. and Crouch2017. Principles of Instrument Analysis. 7th Edition. Published by Cengage learning.**
13. **Hawley, T.S. and R.G. Hawley, 2004. Flow cytometry protocols, 2nd edition, Humana Press.**
14. **GilianMc Mohan, 2007. Analytical Instrumentation. A Guide to Laboratory, portable and miniaturized Instruments. Published by Wiley interscience, 1st Edition.**
15. **SusantaLatiri, 2008. Trace analysis. Narendra Publishing House, New Delhi, 186 pp.**
16. **RasanKatoch, 2011. Analytical Techniques in Biochemistry and molecular Biology; Published by Springer-Verlag New York. 1st Edition.**
17. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1stedition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Sverdrup, H.V., M.W., Johnson and R.H. Fleming.: The Oceans their physics, chemistry and general biology. Prentice- Hall Inc. 1942.**
2. **Boyd,C.E. water Quality in Warm water Fish Ponds, Auburn University, Agricultural Experiment Station, 1979**
3. **Santhanam, R. *et al.,* A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the History, Significance and Scope of Aquaculture, different Aquaculture Practices.
CO2:	To understand the general concepts of Ecology, Biogeochemical cycles, Fertilization and manuring, physico chemical parameters of Soil and water.
CO3:	To understand the different types of ponds, positioning and maintenance of ponds.
CO4:	To understand the criteria for selection of species and cultivable fresh water fishes.
CO5:	To understand the brackish water and marine water cultivable fishes and culture practices.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3		3
CO4	3	3	3	3	3		3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3				3	3		3
CO4		3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	09	12	09	09	15	12	09

Semester-I AQCP 106 Practical – I (Covering course AQCC 101&102)

Credits: 2

Hours: 3

1. **Improving pronunciation through tongue twisters.**
2. **Just a minutes session: Speaking Extempore for one minutes on given topics**
3. **Conversation classes on contemporary issues**
4. **Reading aloud of newspaper headlines and important articles.**
5. **Mannerism or Etiquette.**
6. **Group Discussion**
7. **Letter drafting**
8. **Report writing on a topic**
9. **Writing of corporate CVs**
10. **PPT presentation on selected issues**
11. **Tips to face the interviews**
12. **Mock Interview sessions**

Semester-I AQCP 107 PRACTICAL – II (Covering course AQCC 103)

Credits: 2
Hours: 3

1. **Different components of Taskbar**
2. **Create Desktop icons & Folder and Files on Desktop**
3. **Run Application such as Notepad, MS Paint**
4. **Change Mouse properties in Windows**
5. **Connecting to the Internet, applying browsers software such as chrome, Internet Explorer**
6. **Applying software download**
7. **Create E-mail ID in a mail server, sending E-mail and working with Inbox**
8. **Create Bio data in word**
9. **Formatting text in Word**
10. **Create excel database, apply auto sum**
11. **Create presentation file with multiple slides**
12. **Apply slide transition and animation**
13. **Importing and exporting of files**
14. **Conversion of file from one format to other (.doc to pdf, .jpeg to pdf, etc.)**

Semester-IAQCP 108PRACTICAL – IIII (Covering course AQCC 104)

Practical

Analysis of gut contents.Study of food and feeding habits of finfish and shellfish.Estimation of age and growth by direct and indirect methods.Classification of maturity stages.Estimation of fecundity.Study of development stages. Tagging and marking. Visit to shrimp and prawn hatcheries to study developmental stages. Techniques of induced breeding – dissection, preservation and demonstration of pituitary gland in alcohol and glycerol, rearing of eggs and larvae.

Semester-I**AQCP 109 PRACTICAL - IV (Covering course AQCC 105)**

Soil characteristics: texture –soil trigon method, total organic carbon, soil pH,npk,hydrogen sulphide content, bulk density, water quality parameters analysis: do, salinity, bod, ammonia, h_2s, pH, hardness, alkalinity, nitrate, nitrite; plankton – collection, identification and estimation of primary productivity, farm equipment/instruments – pumps, aerator, feeding tray, refractometer, handheld pphensecchi disc,cast net, cast net efficiency, identification of commercially important phytoplankton and zooplankton, identification of cultivableand commercially important fresh, brackish and marine water fin and shell fishes, identification of aquatic weeds, pellet feeds – types and formulation, types of lime used in aquaculture practice.

Semester II AQCC 201 SOFT SKILL AND PERSONALITY DEVELOPMENT

Credits: 3
Hours: 3

Course Objective

- **To enhance holistic development of students and improve their employability skills.**

Learning Outcomes

- ✓ **Enhance the students Communication ability**
- ✓ **Developing the professionals with idealistic, practical and moral values.**
- ✓ **Enhance theirinter- personal skills and be an effective goal oriented team player.**

UNIT I LISTENING SKILLS

Barriers to listening; effective listening skills; feedback skills.Attending telephone calls; note taking. Activities: Listening exercises - Listening to conversation, News and TV reports. Taking notes on a speech / lecture.

UNIT II SPEAKING AND CONVERSATIONAL SKILLS

Components of a meaning full and easy conversation; understanding the cue and making appropriate responses; forms of polite speech; asking and providing information on general topics.The study of sounds of English, stress and intonation. Situation based Conversation in English.

UNIT III ESSENTIALS OF SPOKEN ENGLISH

Activities, Making conversation and taking turns, Oral description or explanation of a common object, situation or concept, giving interviews.

UNIT IV PRESENTATION SKILL

Oral Presentation with / without audio visual aids.Group Discussion. Listening to any recorded or live material and asking oral questions for listening comprehension.

UNIT V PERSONALITY DEVELOPMENT

Attitude: Factors influencing Attitude, Challenges and lessons from Attitude. Change Management: Exploring Challenges, Risking Comfort Zone, Managing Change. Motivation: Factors of motivation, Self-talk, Intrinsic & Extrinsic Motivators.

TEXT BOOKS

1. **Fredrick H. Wentz, "Soft skills Training - A workbook to develop skills for employment", Createspace, 2012.**
2. **Barun K. Mitra, "Personality Development and Soft skills", Oxford University Press, 2016.**

REFERENCE BOOKS

1. **Covey Sean, "Seven Habits of Highly Effective Teens", Fireside Publishers, 1998.**
2. **Carnegie Dale, "How to win Friends and Influence People", Simon & Schuster, 1998.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the skills of Listening and Barriers to Listening, effective listening skills.
CO2:	To understand the Speaking and Conversation skills, components of a full conversation.
CO3:	To understand the essentials of Spoken English and giving interviews.
CO4:	To understand the Presentation skills, oral presentation and asking questions.
CO5:	To understand the personality development like attitude, Motivation etc.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3				3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4				3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester II AQCC 202 BRACKISH WATER AQUAUCLTURE AND MARICULTURE

Credits: 3
Hours: 3

Objectives

- **To provide basic biology of the species used for brackish water aquaculture and Mariculture.**
- **To give an introduction to brackish water aquaculture practices.**
- **To provide a basic idea about various Mari culture practices.**

Learning Outcomes

- ✓ **Knowledge on the biology and biological cycle of the brackish water & marine cultivable species will be learnt.**
- ✓ **Knowledge on the brackish water culture practices will be learnt by the student.**
- ✓ **Knowledge on the Mari culture will be learnt by the student.**

UNIT I INTRODUCTION

Introduction, history, development and present status of Brackishwater farming in India.Brackishwater as a medium for aquaculture, ecological factors – abiotic and biotic factors.Selection of site, general planning and design of brackish water farms.Aquaculture systems: traditional (pokkali, bheries, gazanis, khazans), semi-intensive, intensive aquaculture

UNIT II BRACKISHWATER

Finfish Culture Selection of cultivable species in brackish water systems, their biology and culture practices – monoculture and polyculture of – *Chanoschanos*, *Mugilcephalus*,*Latescalcarifer*.Nursery, rearing and grow out in ponds, cages and pens.

UNIT III CRUSTACEAN CULTURE

Species of shrimps cultured in Brackishwater and their biology – *Penaeusmonodon*, *Penaeusindicus*, *Litopenaeusvannamei*. Extensive, semi-intensive and intensiveshrimp farming practices. Crab culture (*Scylla serrata*, *Scylla occeanica* and *Charybdis* sp.): Pond design, management of crab farm, fattening process of crab, economics-cage culture and pen culture

UNIT IV MOLLUSCS AND SEAWEED CULTURE

Culture of clams, cockles, edible oyster, pearl oyster and mussel, economic importance of mollusks- Seaweeds Culture, criteria for selection of candidate species in India, biology – life history, growth, reproduction of *Ulva*, *Laminaria*, *Gracilaria* and other economically importance of seaweeds.

UNIT V MARICULTURE

Ecological subdivisions of the sea.Selection of site and selection of materials for sea farming.Different designs of open sea farming structures – construction of cages – bioengineering problems and solutions – scope of open sea farming in India. Important fin fishes cultured in the open seas and the culture systems. (Milk fish, Pearl spot and Mullets). Present status and recent developments inMariculture.

TEXT BOOKS

1. **Welch, P.S. Limnology. McGrawHill, NY, 1952**
2. **Hutchinson, G.E. A Treatise on Limnology, Vols. I & II. John Wiley & Sons,1957.**
3. **Ruttner, F. Fundamentals of Limnology. Translated by D.G. Frey and F.E.Fry University of Toronto Press, 1968.**
4. **Wetzel, R.G. Limnology. W.B. Saunders Co., 1975.**

5. **Reid, G.K. & R.D. wood. Ecology of inland waters and Estuaries. VanNostrandCompany, 1976.**
6. **Cole, C.A. Textbook of Limnology. The C.V. Mosby Co., 1983.**
7. **Friedrich., H. Marine Biology, published by Sidgewick& Jackson, London, United Kingdom (1969).**
8. **Raymont, J.E.C.: Plankton and productivity in the Oceans, Volume 1.**
9. **Balakrishna Nair. N. and D.M. Thampy: A text book of Marine ecology**
10. **Broecker, W.S.: Chemical Oceanography**
11. **Sverdrup, H.V., M.W., Johnson and R.H. Fleming.: The Oceans – Their physics, chemistry and general biology. Prentice-Hall Inc. 1942.**
12. **Dawes, C.J. 1988. Marine Botany. John Willey & Sons, New York, 480**
13. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Pillay, T.V.R 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books), London, 497.**
2. **Krisnamurthy.V and M.Balusamy, 2010. Phaeophyceae of India and neighborhood. Madras Christian College publishing, Chennai, 193.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Introduction to Brackish water aquaculture and different types of Aquaculture systems.
CO2:	To understand the different species cultured in Brackish water aquaculture and their culture practices.
CO3:	To understand the Crustacean species cultured in Aquaculture, their Biology and their

	culture practices.
CO4:	To understand the culture of Mollusks and their importance as well as the culture of seaweeds and importance.
CO5:	To understand the Open sea farming, cage farming, present and current status of Mariculture.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3				3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	15	15	09	09	15	15	09

Semester II AQCC 203 HATCHERY TECHNOLOGY IN AQUATIC ORGANISMS

Credits: 3
Hours: 3

Course Objectives

- **To understand the current methodology and various techniques of commercial seed production.**
- **To develop basic knowledge on the spawning, larval rearing and feeding of the commercially important species.**
- **Hatchery management strategies.**

Learning Outcomes

- ✓ **Knowledge on the biology and biological cycle of the brackish water & marine cultivable species will be learnt.**
- ✓ **Knowledge on the brackish water culture practices will be learnt by the student.**
- ✓ **Knowledge on the Mari culture will be learnt by the student.**

UNIT I FIN AND SHELL FISH BREEDING

Fresh water and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Study of maturity stages in fish.Calculation of fecundity.Brood stock maintenance and selection of fin and shell fish brooders.Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeusmonodon, P. indicus, Macrobrachiumrosenbergii, Scylla serrata,* lobster, edible, oyster, pearl oyster, fresh water mussel.

UNIT II CARP HATCHERY

Hatchery management-seed production of carps.Hypophysation of Indian major carps and exotic carps, history of hypophysation.Pituitary gland.Collection and preservation of gland.Other ovulating agents.Brood stock management, sexing, dosage for injection, mechanism of ovulation. Development of carp eggs, different carp hatcheries. Nursery rearing of carp seed.

UNIT III CARP PRODUCTION SYSTEM AND SEED PRODUCTION OF OTHER FISHES

Production of common carp seeds, breeding techniques.Sundanese, Tjimindi, Rantjapaku and Central Sumatra methods. Methods followed in China and India. Transport of fish seed and brood fishes.Causes of mortality during transport, techniques of transport, open and closed systems, methods of transportation, use of anesthetics. Carp seed resources in major rivers. Bundh breeding, types of bundh breeding techniques. Problems of bundhbreeding.Seed production and nursery rearing of *Clariasbatrachus*, *Mugilcephalus*, *Latescalcarifer*.

UNIT IV SEED PRODUCTION OF CRUSTACEANS AND MOLLUSKS

Seed production and nursery rearing of *Penaeusindicus*, *Penaeusmonodon*and *Macrobrachiumrosenbergii*.Hatchery operations of pearl oysters, clams, crabs, lobster.

UNIT V HATCHERY MANAGEMENT AND DESIGN OF SHRIMP HATCHERIES

Components and general design of hatcheries.Selection criteria for broodstock and brood stock management.Water quality monitoring and management.Quarantine and disease management in hatcheries.Various components, equipment's and infrastructure facilities required in hatchery.Mechanical and biological filters.

TEXT BOOKS

1. **Pillay, T.V.R. & M.A. Dill. Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979.**
2. **Stickney, R.R. Principles of Warm Water Aquaculture. John Wiley & Sons Inc.,1979.**
3. **Hepher, B. & Y. Prugim. Commercial Fish Farming. John Wiley & Sons Inc.,1981.**
4. **Boyd, C.E. Water Quality Management for Pond Fish Culture. ElsevierScientific Publishing Company, 1982.**
5. **Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing CorporationIndia, 1982**

6. **Bose, A.N. et. Al. Coastal Aquaculture Engineering. Oxford & IBH PublishingCompany Pvt. Ltd., 1991.**
7. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering**

REFERENCE BOOK

1. **Turcker, C.S. Channel Catfish Culture. Elsevier, 1985.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Breeding of Fin and Shell fishes.
CO2:	To understand the seed production and Hatchery management of Carps.
CO3:	To understand the production of Common carp seeds and other fishes, their breeding techniques.
CO4:	To understand the seed production of Crustaceans and mollusks and also hatchery operations.
CO5:	To understand the hatchery management and the design of shrimp hatcheries.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	

CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3				3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3
CO5		3	3	3	3	3	3
Total	12	15	09	09	15	15	09

Semester II **AQCC 204 FRESH WATER AQUACULTURE**

Credits: 3
Hours: 3

Course Objectives

- **To understand the techniques involved in freshwater aquaculture practices.**
- **To get a detailed information about freshwater aquaculture.**
- **To provide a basic idea about the importance of live feed in culture systems.**

Learning Outcome

- ✓ **The learners will be aware of all the techniques involved in freshwater aquaculture.**
- ✓ **At the end of the course student can able to gain the knowledge on the fresh water aquaculture practices**

- ✓ **Knowledge on the culture systems will be learnt by the student**

UNIT I FRESHWATER FISH CULTURE

Various freshwater organisms used for aquaculture in India.Culture of Carps-Nursery rearing and stocking ponds – composite fish culture, Preparation of ponds – different methods for the eradication of weed fishes, predators, aquatic insects and aquatic weeds, stocking and post stocking management, harvesting.Culture of air breathing fishes-Channa, Heteropneustes, Clarias, Anabas. Culture of Cold water fishes in India.

UNIT II CULTURE OF PRAWNS, MOLLUSCS AND FROG

Cultivable species of freshwater prawns and their biology – culture of *Macrobrachiumrosenbergii*.Freshwater pearl culture – present status of freshwater pearl culture and production in India.

UNIT III AQUACULTURE FOR STABLE ENVIRONMENT

Sewage fed fish culture, sewage treatment, -Sewage cum fish culture in India.Fish in relation to public health- Larvivores fishes and mosquito eradication using fishes.

UNIT IV RESERVOIR FISHERIES

Major reservoirs in India, measures for increasing production from reservoirs in India and abroad, Game fishery.

UNIT V INTEGRATED FARMING

Recent development in integrated farming - Rice cum fish culture, Duck cum fish culture, Poultry cum fish culture and pig cum fish culture.Organic aqua farming.Fish culture in cages and pens. Running water fish culture.Fish culture in cages and pens, race way, indoor tanks, canals, silo culture and Aqua ponics.Monoculture, polyculture, composite fish culture.

TEXT BOOKS

1. **Welch, P.S. Limnology. Mcgraw Hill Book Company Inc,2nd edition, NY, 1952**
2. **John E Bardach and John H Ryther,1972. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms, published by Wiley.**
3. **Janardhana Rao, K. & S.D. Tripathi. A Manual of Giant Freshwater Prawn**
4. **Hatchery. CIFA, Kausalyaganga, Orissa, India, 1993.**
5. **Iso Matsui. Theory and Practice of Eel Culture. American Publishing Co. Pvt. Ltd., 1980.**
6. **A.B.Chaudhuri –Aquaculture ,limnology and Ichthyology Daya Publishing House ,Year :2009**
7. **Aquaculture –principles and practices,second edition -2005,by Blackwell publishing Ltd –T.V.R. Pillai Fishing News (Books) Ltd., London, 1990.**
8. **R.K. Rath-freshwater aquaculture 2nd edition, published in 2005.**
9. **Hutchinson, G.E. A Treatise on Limnology, Vols. I & II. John Wiley & Sons, 1957.**
10. **Reid, G.K. & R.D. wood. Ecology of inland waters and Estuaries. Van Nostrand Company, 1976.**
11. **Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.**
12. **Korringa, P., 1976. Farming Marine Fishes and Shrimps. Elsevier Publishing Company, Amsterdam, 208: 4.**

13. **Chen, T.P., 1976. Aquaculture Practices in Taiwan. Fishing News (Books) Ltd., London, 160.**
14. **Shigueno, K., 1993. Problems in Prawn Culture. PublisherA.A. Balkema.**
15. **Josianne., G Stottrup and Lesley A. McEroy, 2003. Live feeds in Marine aquaculture. Published by Wiley- Blackwell, 1st edition.**
16. **David, A. Bengtson, 2003. Status of Marine aquaculture in relation to live prey: past, present and future, Wiley - Blackwell.**
17. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1stedition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990.**
2. **Santhanam, R. *et al.* A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.**
3. **Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Book) Ltd., London, 497.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the different fresh water organisms and their culture practices.
CO2:	To understand the culture of crustaceans, mollusks and frog.
CO3:	To understand the importance of fish in stable environment, sewage aquaculture, fish in relation to public health.
CO4:	To understand the Reservoir fisheries and major reservoirs in India.
CO5:	To understand the various types of Integrated Fish farming Rice cum fish culture, Duck cum fish culture, pig cum fish culture etc.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	

CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3				3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3
CO5			3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester II **AQCC 205 CULTURE OF LIVE FISH FOOD ORGANISMS**

Credits: 3
Hours: 3

Course Objectives

- **To provide basic biology of the species used for brackish water aquaculture and mariculture.**
- **To give an introduction to brackish water aquaculture practices.**
- **To provide a basic idea about various Mari culture practices.**

Learning Outcomes

- ✓ **Knowledge on the biology and biological cycle of the brackish water & marine cultivable species will be learnt.**

- ✓ **Knowledge on the brackish water culture practices will be learnt by the student.**
- ✓ **Knowledge on the Mari culture will be learnt by the student.**

UNIT I

Candidate species of Bacterioplankton, phytoplankton and zooplankton as live food organisms for fresh, brackish and marine fin and shell fishes.

UNIT II

Biology and mass culture of microalgae: Methods of collection-Different media used I cultue. Blue green algae- spirulina -green algae diatoms-flagellates- harvesting and processing.Bio-enrichment, bio-film, peri-phyton and bio-flock.

UNIT III

Biology- reproduction and feeding habits of zooplankton-culture requirements of important live feed organisms- infusoria-rotifers-cladocerans-tubifex, copepods, oligochaetes, and insect larvae.

UNIT IV

Artemia- biology- ecological significance- culture for cyst- biomass Production-Culture-use of salt pans for artemia culture. Polychaete biology and diversity, captive mass culture technology and its impotence in brood stock nutrition.

UNIT V

Culture of chironomids-Culture of Earthworms-Bait fish and forage fish- Tropic potentials of different fish food organisms- Maggot production - proximate composition of fresh water and marine species of live feed.

TEXT BOOKS

1. **Cyrino EP & Bureau D & Kapoor BG. 2008. Feeding and Digestive Functions in Fishes. Science Publ.**
2. **Baton Roughe. De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.**
3. **Elena M. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers.**
4. **Guillame J, Kaushik S, Bergot P &Metallier R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publications.**
5. **Halver J & Hardy RW. 2002. Fish Nutrition. Academic Press.**
6. **Halver JE &Tiews KT. 1979. Finfish Nutrition and Fishfeed Technology. Vols. I, II**
7. **Heenemann, Berlin. Hertrampf JW &Pascual FP. 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer.**
8. **Houlihan D, Boujard T &Jobling M. 2001. Food Intake in Fish. Blackwell.**
9. **Lovell RT. 1998. Nutrition and Feeding of Fishes. Chapman & Hall.**
10. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **ADCP (Aquaculture Development and Co-ordination Programme). 1980. Fish Feed Technology. ADCP/REP/80/11. FAO**

2. **D' Abramo LR, Conklin DE & Akiyama DM. 1977. Crustacean Nutrition: Advances in Aquaculture. Vol. VI. World Aquaculture Society**
3. **Lavens P &Sorgeloos P. 1996. Manual on the Production and Use of Live Food for Aquaculture. FAO Fisheries Tech. Paper 361, FAO.**
4. **New MB. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. FAO – ADCP/REP/87/26.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the different live food organisms for the culture of Fresh, Brackish water and marine fishes.
CO2:	To understand the mass culture of diatoms, dianoflagellates and periphyton.
CO3:	To understand the Biology, reproduction and feeding habits of Zoo plankton.
CO4:	To understand the biology and economic significance of Artemia, biology and mass culture of Polychaetes.
CO5:	To understand the culture of Earthworms, Bait fish and Forage fish, Chironomids.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3

CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**				**3**	**3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**3**	**3**	**3**		**3**	**3**	
CO2	**3**	**3**	**3**		**3**	**3**	
CO3	**3**	**3**		**3**	**3**	**3**	**3**
CO4	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**				**3**	**3**
Total	**15**	**15**	**06**	**06**	**12**	**15**	**09**

Semester-IIAQCP 206 PRACTICAL- V (Covering AQCC 201)

Credits: 3

Hours: 6

1. **Classroom technique to improve the soft skills**
2. **Surprise writing on current issues**
3. **General grooming sessions to face the interview**
4. **Group discussions**
5. **Motivational classes to improve communication and confidence power**
6. **Team project on personality development**
7. **Presentation through visual aids**
8. **News reading**

9. **Dialogue delivery**
10. **Change project**

Semester-IIAQCP 207 PRACTICAL - VI (Covering AQCC 202)

Credits: 3

Hours: 6

Identification of important cultivable species.Collection and identification of commercially important seed of fish and shellfishes.Types of fertilizers - Pond preparation.Seed selection, quality and acclimatization.Water quality parameters.Estimation of seed survival.Pond biomass estimation. Material, apparatus and machinery for shore based aquaculture and sea farming. Estimation of feed intake.Growth and health monitoring.Fouling organisms in cages and pens.Collection of molluscan seed – materials, preparation and laying of spat collectors, observation of spat fall. Farm visit to witness seeding, growth, measurement, thinning, harvesting and in situ measurements of production.Induction of spawning by physical, chemical and biological techniques.Identification of locally available and economically impotent seaweeds.Field visit to observe the culture of seaweeds and the technique of harvest.Submission of field report.

Semester-IIAQCP 208 – Practical – VII (Covering AQCC 203)

Credits: 1

Hours: 2

Study of maturity stages in fish.Collection and preservation of fish pituitary gland, preparation of extract, Hypophysation.Calculation of fecundity.Broodstock maintenance and selection of breeders for injection. Different fish hatchery systems, study of fish eggs and embryonic developmental stage. Identification of eggs, spawn, fry and fingerlings of different species.Preparation and management of fish nursery.Fish seed and brood stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding.Water quality monitoring in fish hatcheries and nurseries.Identification of brood stock and maturity stages of important crustaceans and mollusks.Breeding and larval rearing of *Macrobrachiumrosenbergii* and *Penaeusmonodon*.Identification of larval stages of important crustaceans and mollusks.Demonstration of eyestalk ablation in *Penaeusmonodon*.Collection, packing and transportation of shrimp/prawn seed and broodstock.Observations on gonadal maturation of *Penaeusmonodon* and *Macrobrachiumrosenbergii*.Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.

Semester II AQCP 209 – Practical – VIII (Covering AQCC 204)

Credits: 1

Hours: 2

Study of cultivable species of finfish, shellfish. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control.Preparation and management of nursery, rearing and grow-out ponds.Study of effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shell fishes.Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth.

Semester II AQCP 209 – Practical – VIII (Covering AQCC 205)

Credits: 1

Hours: 2

Methods of isolation and identification of different live feed organisms (Bacterioplankton, microalgae, phytoplankton, zooplankton .Blue green algae- spirulina -green algae diatoms-flagellates, bio-film, peri-phyton and bio-flock.Laboratory scale culture (batch and continuous) selected live feed organism - Evaluation of live feed organisms – Decapsulation technique and hatching method of brine shrimp cysts. Infusoria-rotifers-cladocerans-tubifex, copepods, oligochaetes, and insect larvae.chironomids- Culture of Earthworms-Bait fish culture, maggot culture

Semester III **AQCC 301 DISASTER MANAGEMENT**

Credits: 3
Hours: 3

Course Objectives

- **To understand disaster risk, improving disaster risk governance and mitigation**
- **Disaster reduction and disaster preparedness, early warning and restoration in the aftermath of a disaster.**
- **To enlighten the learner with relief, restoration and rehabilitation which lies as the basic of disaster management.**

Learning Outcomes

- ✓ **Knowledge about the disaster in the coastal region and its mitigation measures**
- ✓ **Knowledge about the coping mechanisms**
- ✓ **Knowledge about the relief restoration and rehabilitation in the affected regions**

UNIT I BASIC CONCEPTS

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India.

UNIT II VARIOUS DISASTERS

Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and impact of various disasters.

UNIT III DISASTER MANAGEMENT STRATEGIES

Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures.

UNIT IV RESPONSE AND RECOVERY SYSTEMS

During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation.

UNIT V AGENCIES IN DISASTER MANAGEMENT

Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global levels. Sea safety and health.

TEXT BOOKS

1. **Sinha A. 2001. Disaster Management. National Institute of Disaster Management, Ministry of Home Affairs, Government of India, NewDelhi.**
2. **Bist DS. 2000. Safety and Security at Sea - A Guide to Safer Voyages.Butterworth-Heinemann.**
3. **International Convention for the Safety of Life at Sea. 1974. Universal Publication. Corporation. Mumbai.**
4. **Larkin FJ. 1998. Basic Coastal Navigation. 2nd Ed. Sheridan.**

Course Outcomes

At the end of the course, the student will be able to:

CO1:	To understand the Basic concepts of Disaster.
CO2:	To understand the various types of Disaster – Natural and manmade hazards in Aquaculture and fisheries.
CO3:	To understand the Disease management strategies.
CO4:	To understand the response and recovery systems during the disaster.

CO5:	To understand the different agencies involved in Disaster management.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3		
CO5	3	3	3	3					3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3		
CO5				3	3	3	3
Total	12	12	06	09	15	12	06

Semester III AQCC 302 AQUACULTURE NUTRITION AND FEED MANAGEMENT

Credits: 3
Hours: 3

Course Objectives

- **To provide a basic understanding about fish nutrition.**
- **Provide the knowledge on the Fish feeding physiology, nutritional requirements.**
- **Providing the basic knowledge on the feed composition, formulation of nutritionallybalanced feed, production and use of live feed for optimal production**

Learning Outcomes

- ✓ **Clear knowledge about the fin and shell fish nutrition.**
- ✓ **Knowledge about the feed ration and ratio in aquaculture system.**

- ✓ **Knowledge on the physiology of fish feeding and nutritional requirements will be learnt by the students.**

UNIT I BASIC PRINCIPLES OF NUTRITION

Basic principles of nutrition for fishes and shrimps.Natural foods and artificial feeds, comparison between the feeding of terrestrial animals and fish and prawns.

UNIT II NUTRITIONAL REQUIREMENTS

Nutritional requirements of cultivated fishes and shrimps; energy, proteins, carbohydrates, fats, fiber, minerals and vitamins. Digestion, assimilation and conversion of feed: FCR, biological value etc.

UNIT III FEED FORMULATIONS

Feed formulations, feeds for fish and prawn larval stages, juveniles, grow out stages, brood stock etc., pelleted feeds, additives, preservatives, attractants and Probiotics and feed production

UNIT IV FEED PRESERVATION AND FEEDING MANAGEMENT

Feed storage, Methods of Feeding- Feeding Devices-Demand feeder- Electrically operated automatic feeders- Pneumatic-type automatic feeders- Hydraulic - type automatic feeders- Feeding carts- Feeding boats- Feeding devices for wet or moist feeds. Feeding techniques, rations for cultivated fish and prawns, feed management aspects, nutritional pathology.

UNIT V TYPES OF FEEDS

Different Forms of Feeds - Feeds based on life-cycle of fish- Product quality feeds- Larval feeds- Flakes- Farm-made feeds -Feed additives- Binders- Antioxidants-Enzymes- Pigments- Growth promoters -Feed stimulants- Immunostimulants- Non-conventional feed ingredients and anti-nutritional factors- Digestive enzyme, digestibility and factors affecting digestibility- Protein digestion- Fat digestion- Carbohydrate Digestion- Microbial digestion- Factors affecting digestibility.

TEXT BOOKS

1. **Cyrino EP & Bureau D & Kapoor BG. 2008. Feeding and Digestive Functions in Fishes. Science Publication.**
2. **De Silva SS & Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman & Hall Aquaculture Series.**
3. **Elena M. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers.**
4. **Guillame J, Kaushik S, Bergot P &Metallier R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publication**
5. **Halver J & Hardy RW. 2002. Fish Nutrition. Academic Press.**

6. **Halver JE &Tiews KT. 1979. Finfish Nutrition and FishFeed Technology. Vols. I, II.**
7. **Heenemann, Berlin. Hertrampf JW &Pascual FP. 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer.**
8. **Houlihan D, Boujard T &Jobling M. 2001. Food Intake in Fish. Blackwell.**
9. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1stedition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **ADCP (Aquaculture Development and Co-ordination Programme). 1980. Fish Feed Technology. ADCP/REP/80/11. FAO.**
2. **Lovell RT. 1998. Nutrition and Feeding of Fishes. Chapman & Hall. New MB. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. FAO – ADCP/REP/87/26.**
3. **Lavens P &Sorgeloos P. 1996. Manual on the Production and Use of Live Food for Aquaculture. FAO Fisheries Tech. Paper 361, FAO.**
4. **D' Abramo LR, DE & Akiyama DM Conklin. 1977. Crustacean Nutrition: Advances in Aquaculture. Vol. VI. World Aquaculture Society, Baton Roughe.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the basic principles of Nutrition for Fishes and Shrimps.
CO2:	To understand the nutritional requirements of Cultivable fishes and shrimps
CO3:	To understand the feed formulations.
CO4:	To understand the feed preservation and feed management.
CO5:	To understand the different types of feeds.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3

CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**		**3**			
CO5	**3**	**3**	**3**			**3**	**3**	**3**	**3**	**3**	**3**	**3**

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	**3**	**3**	**3**		**3**	**3**	
CO2	**3**	**3**	**3**		**3**	**3**	
CO3	**3**	**3**		**3**	**3**	**3**	**3**
CO4	**3**	**3**		**3**			
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Total	**15**	**15**	**09**	**09**	**12**	**12**	**06**

Semester III **AQCC 303 INLAND AND MARINE FISHERIES**

Credits: 3
Hours: 3

Course Objectives

- **To introduce the learner to various types of fisheries**
- **To study the riverine, reservoir and estuarine fishery resources**
- **To understand pelagic and demersal marine fishery resources**

Learning Outcome

- ✓ **At the end of the study the learners will be highly equipped with various types of fishery.**
- ✓ **Student learns the knowledge on the inland fishery resources.**
- ✓ **Student learns the knowledge on the pelagic and demersal fishery resources.**

UNIT I RIVERINE AND COLDWATER FISHERIES

Inland fish production in India- Riverine fisheries – major river systems in India, capturefisheries, fishing methods, recent statistics of catches, problems encountered in fisheriesdevelopment of major rivers. Cold water fisheries- major rivers and species – problems encountered in fisheries development of rivers supporting cold water fisheries.

UNIT II RESERVOIR AND ESTUARINE FISHERIES

Reservoir fisheries- Major reservoirs in India- capture fisheries, fishing methods, recent statistics of catches, problems encountered in fisheries.Development Estuarine fisheries- definition and classification of estuaries- capture fisheries- resident and migrant species.Fishing methods, recent statistics of catches, problems encountered in fisheries development of major estuaries.

UNIT III MARINE FISHERIES- PELAGIC RESOURCES

Marine fishery resources in India- important fishing zones including Wadge bank, maritime states. Major pelagic resource groups– sardines, mackerel, anchovies, ribbon fishes, tuna and seer fishes.Methods of fishing - Recent catch statistics of pelagic fisheries.

UNIT IV MARINE FISHERIES- DEMERSAL RESOURCES

Major demersal resource groups- elasmobranchs, cephalopods, silver bellies, flat fishes, crabs, sciaenids, pomfrets, bombay duck, prawns, lobsters, molluscan resources. Methods of fishing, recent catch statistics. Fishery of mud banks.

UNIT V MARINE FISHERIES - DEEP SEA RESOURCES

Major deep sea resources - fishes, shrimps, lobsters – status of deep sea fishing in India. Chartered fishing in India- policies and problems. Marine fish production in India. - Estimated fishery resources – inshore – offshore - deep sea resource. Fishing regulations.

TEXT BOOKS

1. **Thorpe JE Talbot C & Miles MS. (Ed.) 1995. Conservation of Fish and Shell Fish Resource; Managing Diversity. Academic Press.**
2. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Mahanta PC &Tyagi LK. 2003. Participatory Approach for Fish Biodiversity Conservation in North East India. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.**
2. **Menon AGK. 2004. Threatened Fishes of India and their Conservation. Fisheries Survey of India. Michael RR. 1997. Fisheries Conservation and Management. Prentice Hall.**
3. **Pascoe S. 2005. Bycatch Management and the Economics of Discarding. Daya Publication House.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the riverine ad cold water fisheries.
CO2:	To understand the Reservoir and Estuarine fisheries.
CO3:	To understand the Pelagic resources in the Marine Environment.

CO4:	To understand the Demersal resources in the Marine Environment.
CO5:	To understand the Deep sea resources in the Marine Environment.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3			3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	15	15	09	09	15	15	09

Semester III AQCC 304 AQUATIC ECOLOGY AND BIODIVERSITY

Credits: 3
Hours: 3

Course Objectives

- **To understand the aquatic environment and its structures and functions**
- **To study the pond ecosystem and its interaction with environment**
- **To study the animal associations with other biotic and biotic components**

Learning outcomes

- ✓ **Learners will have a detailed knowledge on the aquatic environment, its structure and function.**
- ✓ **Determinative familiarity with the biotic and abiotic components will be gathered.**
- ✓ **Information on biodiversity, pond ecosystem and its interactions will be obtained.**

UNIT I ECOLOGY

Definition; Ecological Hierarchy; Subdivisions of Ecology, Ecosystem: Principles and concepts; Examples of Ecosystems: Ponds,Lakes, Rivers, Estuary, mangrove, corals,

lagoons; Production and Decomposition.

UNIT II STRUCTURE AND FUNCTION OF ECOSYSTEMS

Energy flow: Definition; Laws ofThermodynamics; Energy Environment; Concepts of Productivity; Measurement of primary productivity; Trophic Levels, and Examples; Ecological Pyramids. Biogeochemical Cycles: Patterns and Basic types, cycling of Organic nutrients; Pathways, limiting factors and governing laws. Ecological Indicators.

UNIT III COMMUNITY ECOLOGY:

The bioticcommunity, Conceptsof habitatand ecological Niche; Natural Selection; Ecological Dominance;communityanalysis;species diversity in communities; patternsin communities, ecotones, Population ecology: population group properties, population density and indices of relative abundance. Types of interaction - animal Association-Symbiosis, commensalisms, parasitism, etc.

UNIT IV COASTAL ECOSYSTEMS

Coastal Zone and its classification. Estuaries - classification; physico-chemical factors; biota and productivity; example of some Indian estuaries. Mangroves-definition, mangroveplants, factors affecting distribution. Mangrove flora and fauna.

The sea shore: The Inertial Zone, factors Affecting life on shore, nature of substratum, physical factors, zonation, fauna and flora on a rocky shore, sandy shore, and muddy shore.

UNIT V CONSERVATION OFHABITATS

Endangered species and their conservation, fishpasses for migratory fishes, protectedareas, marine parks and sanctuaries, mangrove afforestation. Artificial reefs. Conservation programmes for endangered species.

TEXT BOOKS

1. **Balakrishnan Nair N and Thampy DM. 1980. A Text Book of Marine Ecology. The MacMillan Co.**
2. **Castro P & Huber ME. 1997. Marine Biology. 2nd Ed. Mc-Graw Hill.**
3. **Duxbury AC, Duxbury AB & Sverdrup KA. 2000. An Introduction to the World's Oceans. 6th Ed. McGraw Hill.**
4. **Gross G. 1993. Oceanography: A View of the Earth. 6th Ed. Prentice Hall.**
5. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **FAO. 1975. Code of Safety for Fisherman and Fishing Vessels. International Maritime Organization, London.**
2. **Prakasan U. 1997. Rule of the Road Signal and Voyage. CIFNET, Cochin**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the definition of Ecology and Ecosystem.
CO2:	To understand the structure and components of Ecosystem.
CO3:	To understand the ecology of different communities.
CO4:	To understand the different coastal ecosystems.

CO5:	To understand the conservation of Habitats – Endangered species.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3		3
CO4	3	3	3				3		3	3		3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3		3
CO4		3		3	3		3
CO5	3	3	3	3	3	3	3
Total	12	15	09	09	15	09	09

Semester III AQCC 305 SOIL AND WATER QUALITY MANAGEMENT

Credits: 3
Hours: 3

- **To study the aquaculture pond dynamics**
- **To understand the pond soil and water characteristics and their optimum requirements to increase the productivity of the ponds.**

Learning Outcomes

- ✓ **Clear knowledge about the water quality parameters required for the different aquaculture system**
- ✓ **By the end learners will get acquainted with the aquaculture pond dynamics.**
- ✓ **Knowledge about the pond bottom soil quality and its management**

UNIT I HYDROLOGY

Water temperature, turbidity, pH, conductivity, Salinity, chlorinity, dissolved oxygen, free carbon dioxide, alkalinity, hardness, nitrites, nitrates, phosphates and ammonia etc.

UNIT II ANALYTICAL METHODS

Laboratory, apparatus, glassware, balances and equipment-uses and maintenance.Collection and preservation of water samples.Common methods of analysis of soil and water quality parameters. Water quality standards

UNIT III SOIL CHARACTERISTICS

Physical properties of soil, soil texture, soil types, Classification of soil. Collection and preservation of soil samples: Soil quality parameters: Conductivity, pH organic carbon, available nitrogen, available phosphorus, total nitrogen, potassium, lime, manures and chemical fertilizers their interaction with water and soil.

UNIT IV SOIL MANAGEMENT

Properties of water logged soils, acidic and alkaline soils, amelioration of problem soils, and management of water and soil quality for aquaculture.

UNIT V SOIL AND WATER AMENDMENTS

Amendments – lime, manure fertilizers, micronutrients, zeolites, alum, gypsum: environment amelioration – chlorination deodorizers, bacterial formulation, Soil and water probiotics for aquaculture ponds

TEXT BOOKS

1. **Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.**
2. **Boyd CE. 1979. Water Quality in Warm Water Fish Ponds. Auburn University. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.**
3. **Parsons TR, Maita Y &Lalli CM. 1984. A Manual of Chemical and Biological Methods for Seawater Analysis. Pergamon Press.**
4. **Sharma LL, Sharma SK, Saini VP & Sharma BK. (Eds.). 2008. Management of Freshwater Ecosystems. Agrotech Publication Academy.**

REFERENCE BOOKS

1. **APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D. C.**
2. **Adhikari S & Chatterjee DK. 2008. Management of Tropical Freshwater Ponds. Daya Publication**
3. **Rajagopalsamy CBT &Ramadhas V. 2002. Nutrient Dynamics in Freshwater Fish Culture System. Daya Publication.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the different parameters of Water – Temperature, pH, Turbidity, Chlorinity etc.
CO2:	To understand the analytical methods of water quality parameters.
CO3:	To understand the different characteristics of soil
CO4:	To understand the soil management.
CO5:	To understand the amendments of soil.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3		3
CO4	3	3	3				3		3	3		3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3		3
CO4		3		3	3		3
CO5	3	3	3	3	3	3	3
Total	12	15	09	09	15	09	09

Semester-III AQCP 306 – Practical – IX(Covering AQCC 302)

Credits: 3

Hours: 6

Preparation of supplementary feeds with locally available ingredients, proximate analysis of feeds. Determination of water stability of pellet feeds. Feed calculation. Observations on bag feeding in fish ponds and check-trays in shrimp farming ponds. Estimation of FCR.Preparation of artificial feeds using locally available feed ingredients. Determination of sinking rate and stability of feeds.Effect of storage on feed quality.

Semester-IIIAQCP 307 – Practical – X(Covering AQCC 303)

Credit: 1

Hours: 2

Demonstration of laboratory glassware, equipment and analytical instruments.Preparation of solutions, collection, preservation and analysis of water samples. Measurement of temperature, turbidity, pH, Salinity chlorinate, dissolved oxygen, free carbon dioxide, total

alkalinity, total hardness, nitrates and phosphates. Collection and processing of soil samples; analysis of soil conductivity, soil texture, soil texture, soil pH, organic carbon, available and total nitrogen, available phosphorus and lime requirement.

Semester-IIIAQCP 307 – Practical – XI(Covering AQCC 303)

Credit: 1

Hours: 2

Visit to inland and marine fish landing centres; sampling, collection and familiarization of commercially important groups viz., marine and freshwater teleost, elasmobranchs, crustaceans, mollusks and seaweeds; observation and analysis of marine catches by major crafts and gears; observation and analysis of species composition of commercial inland fish catches at landing and assembling centres; observation and experimental operations of selected fishing gears in inland / estuarine waters; Maintenance of records of marine and inland fish catch data; GIS and Remote Sensing in capture fishery.

Semester-IIIAQCP 307 – Practical – XII(Covering AQCC 304)

Credit: 1

Hours: 2

Visit to a lake, natural pond\estuaries \swamp\marsh\river\flood plain\ reservoir and marine protected areas. Study of the habitat, biotic communities, and species diversity and their adaptive characters/ associations. Visit to a mangrove forest, collection and identification of mangrove flora and fauna. Visit to a rocky shore to study zonation and physico-chemical conditions. Collection and identification of Rocky shore flora and fauna. Visit to a sandy shore to study zonation and physico-chemical conditions.Collection and identification of sandy shore flora and fauna. Visit to a muddy shore to study zonation andphysico-chemical conditions. Collection and identification of muddy shore flora and fauna.Collection and identification of corals and coral reef biota. Visit to marine structures on the coast, collection and identification of Borers and Fouler organisms, assessment of the damages and appraisal of remedial measures. Visit to a marine park/sanctuary. Understanding the steps involved in protecting endangered habitats and species (Horse shoe crab, Marine turtles, sharks and marine mammals).

Semester-IV **AQCC 401 ENTREPRENEURSHIP**

Credits: 4
Hours: 4

Course Objectives

- **To introduce the accounting and financial aspects of aquaculture**
- **To study the aquaculture marketing strategy**
- **To study the knowledge centres and its role in the access to the aquaculture**

Learning Outcomes

- ✓ **Knowledge about the financing in fisheries and aquaculture sector**
- ✓ **Students will gather interest and knowledge on marketing strategy and entrepreneurship**
- ✓ **Clear knowledge about the entrepreneurial nuances of fishery and allied sectors**

UNIT I ACCOUNTING AND FINANCE

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for

capital expenditure and for working; Statutory and legal requirements for starting a company/venture;

UNIT II MARKETING & NEGOTIATIONS/STRATEGY

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/ Advertising; Services Marketing

UNIT III INFORMATION TECHNOLOGY

How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management.

UNIT IV HUMAN RESOURCE DEVELOPMENT (HRD)

Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up.

UNIT V FUNDAMENTALS OF ENTREPRENEURSHIP & ROLE OF KNOWLEDGE CENTRE AND R&D

Support mechanism for entrepreneurship in India, Knowledge centres like universities and research institutions; Role of technology and up gradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

TEXT BOOKS

1. **Hine, D. and J. Kapeleris, 2006. Innovation & Entrepreneurship in Biotechnology, An International Perspective- Concepts, Theories and Cases, Edward Elgar Publishing Limited.**
2. **Patzelt, H. and T. Brenner (Eds.), 2008. Handbook of bioentrepreneurship International Handbook Series on Entrepreneurship, Springer Science Business media LLC, 294pp.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Accounting and Finance, starting a venture.
CO2:	To understand the Marketing and Negotiations/ strategies.
CO3:	To understand the Information technology for Business administration, Importance of IT.
CO4:	To understand the leadership qualities, Team work qualities, managerial skills.
CO5:	To understand the Fundamentals of Entrepreneurship, Role of Knowledge center, R&D.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3				3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester-IV AQCC 402 GENETICS AND BIOTECHNOLOGY

Credits: 4

Hours: 4

Course Objectives

- **To acclimatize the students to the basic concepts of genetics and biotechnology.**
- **To provide basic idea about the principles of genetics and depict the hereditary mechanism in cultured species.**
- **To acquaint with the state of the art techniques in biotechnology and its application in aquaculturesector**

Learning Outcomes

- ✓ **Knowledge on heredity determination will be learnt.**
- ✓ **Principles of Biotechnology and its applications in the aquaculture will be learnt**
- ✓ **Student will learn the concept of Mendelian genetic principles.**

UNIT I BASIC GENETICS

Introduction – Genetics, Mendel's law. Principles of fish genetics.Cytogenetics, quantitative genetics, population genetics.

UNIT II BREEDING AND QUARANTINE

History and present status of selective breeding programs in aquaculture.Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences.Domestication methods.Seed certification and quarantine procedures.

UNIT III HYBRIDIZATION

Cryopreservation of gametes. Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes.

UNIT IV GENETIC MANIPULATION

Chromosome structure and its manipulation. Sex-reversal and Sex control. Role of steroid in sex reversal.Triploidy, polyploidy, Androgenesis and Gynogenesis and its application in fish culture.Genetic resources of India and Conservation.

UNIT V BIOTECHNOLOGY

Recombinant DNA technology, determinants of DNA replication, cloning, vectors, transformation.Gene manipulation in fish, transgenic fish production.Molecular disease diagnostics.Use of probiotics and antibiotics in aquaculture operations.

TEXT BOOKS

1. **Douglas T. 1998. Genetics for Fish Hatchery Managers. Kluwer. Springer ISBN 978-0-442-00417-0.**
2. **Dunham RA. 2004. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI, 2nd EditionISBN: 978-1-84-593651-8. 495pp.**
3. **Malvee S. 2008. Fish Genetics. SBS Publisers.ISBN 10: 8189741632 ISBN 13: 9788189741631.**
4. **Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Published by Dominant, New Delhi. ISBN 10: 8178885654 / ISBN 13: 9788178885650.**
5. **Padhi BJ andMandal RK. 2000. Applied Fish Genetics. Fishing Chimes.190 pp., ISBN 8186110011.**
6. **Pandian TJ, Strüssmann CA and Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. Science Pulication.**
7. **Reddy PVGK. 2005. Genetic Resources of Major Indian Carps. Daya Publ.**
8. **Reddy PVGK, Ayyappan S, Thampy DM and Gopalakrishna. 2005. Text Book of Fish Genetics and Biotechnology. ICAR.**
9. **Sinnot EW, Dunn L and Dobzansky T. 1989. Principles of Genetics. McGraw Hill.**

REFERENCE BOOKS

1. **Das P and Jhingran AG. 1976. Fish Genetics in India. Today & Tomorrow Publication.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Introduction to Genetics and Principles of Fish Genetics.
CO2:	To understand the present Breeding and Quarantine methods in Aquaculture.
CO3:	To understand the cryopreservation of gametes and Hybridization techniques.
CO4:	To understand the Genetic manipulations.
CO5:	To understand the DNA technology and DNA replication techniques.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1	**3**		**3**	**3**		**3**	**3**	**3**		**3**	**3**	
CO2	**3**		**3**			**3**	**3**	**3**		**3**	**3**	
CO3	**3**		**3**		**3**				**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CO1	**3**	**3**	**3**		**3**	**3**	
CO2	**3**	**3**	**3**		**3**	**3**	
CO3				**3**	**3**	**3**	**3**
CO4	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Total	**12**	**12**	**09**	**09**	**15**	**15**	**09**

Semester-IV **AQCC 403 PATHOLOGY IN AQUACULTURE**

Credits: 4

Hours: 4

Course Objectives

- **To understand the various types of diseases among the cultivable fin and shell fishes**
- **To learn and apply methods to control and disease preparedness strategy in the field**
- **To understand recent tools for diagnosis and disease management strategies.**
- **To understand the role of environment as an important player in infectious diseases in the controlled environment**

Learning outcomes

- ✓ **Knowledge on the aquatic diseases will be obtained.**
- ✓ **Students will have an idea on precautionary measures to be adopted in case of infection to prevent the spread of the disease.**
- ✓ **Students will gain knowledge on the disease diagnostic tools.**

UNIT 1: PATHOLOGY AND PARASITOLOGY

Introduction to fish diseases –Definition and categories of diseases – Disease and environment.Pathology and parasitology. Stress as a factor in the occurrence of diseases. Parasitism – host-parasite relationship.

UNIT II FUNGAL AND VIRAL DISEASES

Fungal diseases (finfish) – Saprolegniosis, brachiomycosis, ichthyophorus diseases.Lagenidium diseases – Fusarium disease Viral diseases (finfish) – IPN, IHN, Viral HemorrhagicSepticemia, Spring Viremia of carps – Major CCVD, Carp lymphocytes.Major shrimp viral diseases – *Bacculoviruspenaeii*, MonodonBacculovirus, Bacculoviralmidgut necrosis, IHHNV, Hepatopancreaticparvo like virus, Yellow head bacculovirus, white spot bacculovirus.

UNIT III BACTERIAL, PROTOZOAN AND METAZOAN DISEASES

Common bacterial diseases (Enteric red mouth disease, Bacterial cold water disease furunculosis, vibriosis, dropsy and Gill and fin rot) their diagnosis and treatment. Protozoan diseases- Ichthyophthiriasis, Costiasis, whirling diseases, trypanosomiasis.Metazoan Diseases- diseases caused by annelids, helminthes, crustaceans and molluscs.

UNIT IV NUTRITIONAL DISEASES AND IMMUNOLOGY

Nutritional pathology – lipid liver degeneration, Vitamin and mineral deficiency diseases.Aflatoxin and dinoflagellates. Defence mechanism in fish and shell fish, Application and development of vaccines.Diagnostic tools – immune detection- DNA/RNA techniques.General preventive methods and prophylaxis.

UNIT V FISH HEALTH MANAGEMENT

Good pond management practices- Eco-friendly and sustainable aquaculture. Quarantine.Methods of pathological examination of fish and infectious diseases.Production of disease-free seeds.Evaluation criteria of healthy seeds. Good Feed management for healthy organisms. Zero water exchange. Probiotics in health management.

TEXT BOOKS

1. **Andrews C, Excell A and Carrington N. 1988. The Manual of Fish Health Salamander Books.**
2. **Sindermann CJ. 1990. Principal Diseases of Marine Fish and Shellfish. Vols. I, II. 2nd Ed. Academic Press.**
3. **Schaperclaus W. 1986. Fish Diseases. Vols. I, II. Oxonian Press.**
4. **Jorge E, Helmut S, Thomas W and Kapoor BG. 2008. Fish Diseases. Science Publication. Volumes 1 and 2.**
5. **Humphrey J, Arthur JR, Subasinghe RP and Phillips MJ. 2005. Aquatic Animal Quarantine and Health Certification in Asia. FAO Publication.**
6. **Inglis V, Roberts RJ and Bromage NR. 1993. Bacterial Diseases of Fish. Oxford: Blackwell Scientific Publications.**
7. **Iwama G and Nakanishi T. (Eds.). 1996. The Fish Immune System Organism, Pathogen and Environment. Academic Press.Volume 15, 1st Edition.**
8. **Roberts RJ. 2001. Fish Pathology. WB Saunders, 3rd Ed.**
9. **Shankar KM and Mohan CV. 2002. Fish and Shellfish HealthManagement.UNESCO Publications.**

10. **Woo PTK and Bruno DW. (Eds.). 1999. Fish Diseases and Disorders. Vol. III. Viral, Bacterial and Fungal Infection. CABI.**
11. **Walker P and Subasinghe RP. (Eds.) 2005. DNA Based Molecular Diagnostic Techniques: Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases. FAO Publ, ISBN 92-5-104420-1.**
12. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Felix S, Riji John K, Prince Jeyaseelan MJ &Sundararaj V. 2001. Fish Disease Diagnosis and Health Management. FisheriesCollegeandResearch, Institute, T. N. Veterinary and AnimalSciencesUniversity. Thoothukkudi.**
2. **Humphrey J, Arthur JR, Subasinghe RP and Phillips MJ. 2005. Aquatic Animal Quarantine and Health Certification in Asia. FAO Publication.**
3. **Wedmeyer G, Meyer FP and Smith L. 1999. Environmental Stress and Fish Diseases. Narendra Publication House. Book 5.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Introduction to pathology and parasitology – Fish diseases.
CO2:	To understand the different types of Fungal and diseases in Fin fishes in Aquaculture.
CO3:	To understand the Bacterial, Protozoan and Metazoan diseases in Aquaculture.
CO4:	To understand the Nutritional diseases and Immunology.
CO5:	To understand the Management of Fish diseases..

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3				3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester-IV AQCC 404 FISH PROCESSING TECHNOLOGY AND QUALITY CONTROL

Credits: 4

Hours: 4

Course Objectives

- **To empower students with present day technologies involved in fish processing and to provide a firm understanding on the various quality requirements in seafood processing**
- **To understand the preservation technology available in the field**
- **To provide information about the various value added marine food products in the market and also its processing technology**

Learning Outcomes

- ✓ **The ultimate outcome of the study is that the students will get an updated knowledge on fish processing technology**
- ✓ **Knowledge on quality requirements in seafood processing and preservation technology will be learned.**
- ✓ **Students will get to know about the value added marine food products in the market and its processing techniques.**

UNIT I INTRODUCTION OF FISH PROCESSING AND FREEZING

Introduction of fish processing, global supply and demand.Principles of fish preservation-Precautions taken in handling fish in the fishing vessel, landing center and processing plant. Fundamental principles involved in chilling and freezing of fish and fishery products. Various freezing methods used in shrimps and fishes Preservation by refrigerated seawater and chilled sea water.

UNIT II PRESERVATION TECHNIQUES OF FINFISH/SHELL FISH PROCESSING

Principles of preservative methods - Drying, Salting, Smoking and Canning.Principles of freeze drying. Accelerated freeze drying and packing of freeze dried products. Modern methods of preservation by irradiation and modified atmospheric storage.

UNIT III FISH BY-PRODUCTS

Fish meal.Dry reduction and wet reduction methods – specification – packaging and storage. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application. Shrimp wastes – chitin – chitosan - production – uses. Fish protein concentrate.Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrates and their incorporation to various products.

UNIT IV VALUE ADDED BY-PRODUCTS

Fish silage – acid silage – fermented silage – application. Fish maws, shark leather fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach - de - mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

UNIT V QUALITY CONTROL

Basic concepts and quality control in fish processing. Salient features of sea food quality and factors. Standards of Sea food. Concepts of Hazard Analysis Critical Control Point (HACCP), Good Manufacturing Practice (GMP), Sanitary Standard Operating Procedure (SSOP). Determining the quality assurance of sea food.

TEXT BOOKS

1. **Balachandran KK. 2002. Fish Canning Principles and Practices. CIFT,Cochin.**
2. **Gopakumar K. 2002. Text Book of Fish Processing Technology. ICAR.**
3. **Hall GM. (Ed). 1992. Fish Processing Technology. Blackie.Spinger science and business.**
4. **Hersom AC and Hulland ED. 1980. Canned Foods. 7th edition. Chemical Publ. Co.**
5. **Larousse J and Brown BE. 1997. Food Canning Technology. Wiley VCH.**
6. **Nambudiri DD. 2006. Technology of Fishery Products. Fishing Chimes.**
7. **Stumbo. 1973. Thermo Bacteriology in Food Processing. 2nd edition CRC, Academic Press.**
8. **Thorne S. 1991. Food Irradiation. 1st edition Elsevier.**
9. **Venugopal V. 2006. Seafood Processing. 1st edition Boca Raton CRC Press.**
10. **Balachandran KK. 2001. Post-Harvest Technology of Fish and Fish Products. Dayabooks.**
11. **Gopakumar K. 1993. Fish Packaging Technology - Materials and Methods. 1st edition. Concept Publishing co.**

12. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Warne D. 1988. Manual on Fish Canning. FAO Fisheries Tech. Paper 285**
2. **Zeathen P. 1984. Thermal Processing and Quality of Foods. 1st edition Elsevier**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the different Fish processing and Freezing techniques.
CO2:	To understand the preservation of Fin fish / Shell fish processing.
CO3:	To understand the By-products of Fishes.
CO4:	To understand the Value added By-products.
CO5:	To understand the Quality Control.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	

CO2	3	3	3		3	3	
CO3				3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester-IV **AQCC 405ANATOMY OF FIN FISH AND SHELL FISH**

Credits: 4

Hours: 4

Course Objectives

- **To introduce the learner to general morphology and anatomy of fin & Shell fishes**
- **To study the physiological characteristics of fin& shell fishes**
- **To provide the knowledge on the anatomy characteristics of the fin & shell fishes**

Learning objectives

- ✓ **By the end of the course the students will be equipped with the knowledge of morphology and anatomy of fin & Shell fishes.**
- ✓ **Knowledge on the physiological characteristics of fin & shell fishes will be learnt by the student.**
- ✓ **Students will gain knowledge on the anatomical characteristics of the fin and shell fish.**

UNIT I EXTERNAL ANATOMY

Oral region and its associated structure; Digestive system and its associated glands - Cell structure, tissue and body organization - External anatomy of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg.Cuttlefish) - Oral region and its associated

structures; digestive system and associated digestive glands of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg. Cuttlefish)

UNIT II CIRCULATORY SYSTEM

Circulatory system of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg. Cuttlefish)

UNIT III RESPIRATORY AND SKELETAL SYSTEMS

Respiratory system of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg.Cuttlefish) - Skeletal system of teleost / elasmobranch.

UNIT IV REPRODUCTIVE & EXCRETORY SYSTEMS

Urino-genital system and Endocrine system - Reproductive and Excretory systems (Urino-genital system) of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg.Cuttlefish) - Endocrine systems of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg.Cuttlefish).

UNIT V NERVOUS SYSTEM AND SENSE ORGANS

Nervous system of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg.Cuttlefish) - Sense organs of teleost; elasmobranch; crustacean (Eg.Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg.Freshwater mussel) and cephalopod (Eg.Cuttlefish).

TEXT BOOKS

1. **Lagler, K.F., J.E. Bardach and R.R. Miller, 1962. Icthyology. John Wiley & Sons Inc., New York, 545 pp.**
2. **Carl E. Bond, 1979. Biology of Fishes. W.B. Saunders Company, Philadelphia, 514 pp.**
3. **Jones, F.R.H., 1968. Fish Migration. Edward Arnold Ltd., London, 325 pp.**
4. **Milne, P.H.1972. Fish and shellfish farming in the coastal waters Fishing News(Books) Ltd.London.**
5. **S. Ayyappan, J. K. Jena, A. Gopalakrishnan and Dr. A. K. Pandey, Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1st edition, 2006. Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006 - Technology & Engineering.**

REFERENCE BOOKS

1. **Santhanam R. Ramanathan and G.Jagadessan 1990. Coastal Aquaculture in India. 1st edition. CBS Publication, India**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the External Anatomy of Fishes.
CO2:	To understand the Circulatory system of Teleost, Elasmobranch and Crustaceans.
CO3:	To understand the Respiratory system of Teleost, Elasmobranch and Crustaceans.
CO4:	To understand the Reproductive system of Teleost, Elasmobranch and Crustaceans.
CO5:	To understand the Nervous system of Teleost, Elasmobranch and Crustaceans.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	

CO3				**3**	**3**	**3**	**3**
CO4	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Total	**12**	**12**	**09**	**09**	**15**	**15**	**09**

Semester-IV AQCP 406 – Practical – XIII(Covering AQCC 402)

Credit: 1

Hours: 2

1. **Collection of fish blood and its analysis.**
2. **PCR, ELISA and Agarose Gel Electrophoresis.**
3. **Protocol of Cryopreservation of gametes.**
4. **Quantitative and qualitative determination of fish gametes like sperm motility, viability, counts.**
5. **Problems on Mendelian inheritance, linkage and crossing over, monohybrid and dihybrid ration, epistasis, pleotropism. Mitotic and meiotic chromosome preparation.**
6. **Demonstration of protocol of androgenesis, gynogenesis and polyploidy.**
7. **Cryopreservation protocols, Quality evaluation of fish milt.**

Semester-IV AQCP 407 – Practical – XIV(Covering AQCC 403)

Credit: 1

Hours: 2

Collection preservation, Identification of disease causing agents.Preparation of media for culture, Familiarization with techniques of bacterial culture and identification, fungal isolation, characterization. Preparation of the list of chemicals and drugs used to control the diseases and medicines, visit to fish and shrimp farms and Disease diagnostic centers.Collection, preservation and identification of parasites, preparation of case studies of diseased fish and prawns.Study of life-cycle stages.Estimation of dose and administration of various chemicals and drugs. Visit to fish farms. Shrimp farms and diagnosis of diseases.

Semester-IV **AQCP 408 – Practical – XV(Covering AQCC 404)**

Credit: 1

Hours: 2

Preparation of fish meal, fish liver oil, Agar-agar, fish skin, fish glue, pearl essence, fish sauce, fish and prawn pickles, fish and prawn wafers, fish soup powder, fish cutlets, fish and prawn breaded and battered products, fish protein concentrate, and fish burger.Techniques of fish preservation, Smoking, canning, freezing. HACCP & GMP with SSOP.

Semester-IV **AQCP 409 – Practical – XVI(Covering AQCC 405)**

Credit: 1

Hours: 2

Dissection of different shellfishes and finfishes to understand their internal organs– digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs.Structure of endocrine glands.

Semester-V **AQCC 501LIMNOLOGY**

Credits: 4

Hours: 4

Course Objectives

- **To learn the ecological functions of inland water bodies**
- **To study the importance of primary productivity and its importance in fresh water bodies**
- **To familiarize the lotic and lentic water bodies and its ecological importance**

Learning Outcomes

- ✓ **Clear knowledge on the ecological functions of inland water bodies**
- ✓ **Detailed knowledge on primary productivity and its importance in fresh water bodies**
- ✓ **Complete knowledge on lotic and lentic water bodies**

UNIT I INTRODUCTION TO LIMNOLOGY:

Inland water types, their identities and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments.Lakes - their origin and diversity. Famous lakes of the world and India; nature of Lake Environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence

of physical and chemical conditions on living organisms in inland waters.

UNIT II PLANKTON

Planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton: seasonal changes of body form in planktonic organisms; food of planktonic organisms. Primary productivity; Aquatic plants: character, classification, zonation, seasonal relations, quantity produced chemical composition distribution in different waters, limnological role.

UNIT III NEKTON:

Composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna.

UNIT IV PRODUCTIVITY

Circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment.

UNIT V LOTIC ENVIRONMENTS

Running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments.Influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

TEXT BOOKS

1. **Nath S. (Ed.). 2008. *Recent Advances in Fish Ecology Limnology and Eco Conservation*. Vol. VII. Narendra Publ. House.**
2. **Allan JD. 1995. *Stream Ecology: Structure and Function of Running Waters*. Chapman & Hall.**
3. **Dodds WK. 2002. *Freshwater Ecology: Concepts and Environmental Applications*. Academic Press.**
4. **Good RE, Whigham DF and Simpson RL. 1978. *Fresh Water Wetlands: Ecological Processes and Management Potential*. Academic Press.**

REFERENCE BOOKS

1. **Hynes HBN. 1970. *Ecology of Running Waters*. Liverpool University, Press, Liverpool.**
2. **Mitsh WJ and Gosselink JG. 1996. *Wetlands*. John Wiley & Sons.**
3. **Pattern BC. 1990. *Wetlands and Shallow Continental Water Bodies*. SPB Academic Press.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the different inland water types: Streams, rivers, lakes and ponds.
CO2:	To understand the Plankton, types of plankton and distribution of plankton and Primary production.
CO3:	To understand the Nekton – Benthos and Periphyton composition and classification.

CO4:	To understand the classification of lakes and production of lakes.
CO5:	To view the different lotic environments.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**3**		**3**	**3**		**3**	**3**	**3**		**3**	**3**	
CO2	**3**		**3**			**3**	**3**	**3**		**3**	**3**	
CO3	**3**		**3**		**3**				**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**3**	**3**	**3**		**3**	**3**	
CO2	**3**	**3**	**3**		**3**	**3**	
CO3				**3**	**3**	**3**	**3**
CO4	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Total	**12**	**12**	**09**	**09**	**15**	**15**	**09**

Semester-V **AQCC 502 MOLLUSCS AND SEAWEED CULTURE**

Credits: 4
Hours: 4

Course Objectives

- **To learn the biology of commercially important molluscs**
- **To study the molluscan seed resources and production**
- **To familiarize the seaweed culture technology**

Learning Outcomes

- ✓ **Detailed knowledge on biology of commercially important molluscs**
- ✓ **Clear knowledge on molluscan seed resources and production**
- ✓ **Complete knowledge on seaweed culture technology**

UNIT 1 BIOLOGY OF MOLLUSKS

Biology of cultivable molluscs – life history, food and feeding, age and growth and reproduction.

UNIT 2 MOLLUSCAN SEED RESOURCES

Seed from Nature Natural seed resources, utilization, and ideal condition for seed fall in nature, distribution of seed, time of seed abundance, seed collection techniques for different species, transportation, seed quality and selection.

UNIT 3 MOLLUSCAN SEED PRODUCTION

Hatchery production of molluscan seed - need for hatcheries for molluscs, brood stock management, induced maturation and spawning, larval rearing &microalgal culture for

feeding spat settlement, ideal spat collectors, rearing of juveniles to stockable size, water quality management, transportation.

UNIT 4 MOLLUSK CULTURE

Culture technology – culture operations, rearing, transportation, monitoring of growth, monitoring of environmental parameters, causes of mortality, different culture techniques and various steps involved in detail and problems encountered on the culture of clams, cockles, edible oyster, pearl oyster and mussel, economic importance of molluscs.

UNIT 5 SEAWEED CULTURE

General introduction to seaweeds – criteria for selection of candidate species in India, biology – life history, growth, reproduction of Ulva, Laminaria, GracilariaKappaphycus. Seaweed culture – technology for higher yields, products from seaweeds (agar, algin and carageenan) and extraction methods.

REFERENCE BOOKS

1. **Pillay, T.V.R 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books), London, 497 pp.**
2. **Milne, P.H., 1972. Fish and Shellfish Farming in the Coastal Water. Fishing News (Books), London, 208 pp.**
3. **Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.**
4. **Dawes, C.J. 1988. Marine Botany. John Willey & Sons, New York, 480 pp.**
5. **Santhanam, R., Ramanathan and G. Jegadessan, 1990. Coastal Aquaculture in India. CBS Publication, India, 180 pp.**
6. **John E. Bardach, 1997. Sustainable Aquaculture. John Willey & Sons, Inc., New York, 251 pp.**
7. **Thomas, P.C., 1998. Current and Emerging Trends in Aquaculture, Daya Pub., Delhi, 422 pp.**
8. **Robert R. Stickney, 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York, 1063 pp. 9. Krisnamurthy.V and M.Balusamy, 2010. Phaeophyceae of India and neighborhood. Madras Christian College publishing, Chennai, 193pp.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the biology of Molluscs, life history, food and feeding, age and growth.
CO2:	To understand the Molluscan seeds from natural resources, collection of seeds and transport.
CO3:	To understand the hatchery production of Molluscan seed, breeding and spat collection.
CO4:	To understand the culture practices of Molluscs.
CO5:	To view the culture practices of Seaweeds.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	

CO3				3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester-V AQCC 503 AQUACULTURE ENGINEERING

Credits: 4

Hours: 4

Course Objectives

- **To understand the knowledge about fish farm survey and measurements**
- **To learn about the pipes , pumps and water flow**
- **To familiarize soil character, types and budgeting**

Learning Outcomes

- ✓ **Detailed knowledge on fish farm survey and measurements**
- ✓ **Clear knowledge on pipes , pumps and water flow**
- ✓ **Complete knowledge on soil character, types and budgeting**

UNIT I LAND SURVEY

Area calculation of plain surface of regular and irregular shape as applied to measurement of land, trapezoidal rule, Simpson's rule, volume of regular and irregular shape as applied to the volume of stacks, sheds and heaps.

UNIT II FARM-TYPES

Fresh water and coastal aquafarms. Preliminary survey, site selection, topography. Land survey - chain surveying, compass surveying, leveling, plane table surveying and contour surveying

UNIT III **WATER**

Introduction – Pipe and pipe parts; Water flow and head loss in channels and pipe systems. Pumps – Types of pumps; Pumping of water requires energy; Centrifugal and propeller pumps; Changing of water flow of pressure; Regulation of flow from selected pumps. Increased focus on water quality; Inlet water; Outlet water; water treatment.Water

budgeting.Water control structure - types of inlets and outlet.Main feeder channel, drainage channel

UNIT IV AERATION AND RECIRCULATION

Principles, classification and placement. Pumps - types, total head and horse power. Filters - types and construction. Design and construction of aerators – Basic principles; Evaluation criteria; Types of aerator; Oxygenation of water. Recirculation and water use systems – Definitions – Degree of re-use; water exchange in relation to amount of fish; Degree of purification. Components in a re-use system; Instruments and monitoring – Measuring water quality; measuring physical conditions; counting fish; measuring fish size and total fish biomass.

UNIT V SOIL

Soil - types, properties, classification, sampling methods and texture analysis. Location, design and construction of hatcheries, race ways and farm complex. Tide-fed / pump fed farms, creeks, estuarine and marine water source utilization. Open canals and their types. Sluices and gates.Design and construction of ponds and dykes.Tidal influences and maintenance; Effect of seepage and evaporation and their control.Inlet and out-let construction.

REFERENCE BOOKS

1. **Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News(Book) Ltd., London, 497 pp.**
2. **Bardach, J.E., J.H. Ryther and W.O. McLarney, 1972. Aquaculture: Farming andHusbandry of Freshwater and Marine Organisms. Wiley Interscience, New York, 868 pp.**
3. **Korringa, P., 1976. Farming Marine Fishes and Shrimps. Elsevier Publishing Company,Amsterdam, 208 pp.**
4. **Chen, T.P., 1976. Aquaculture Practices in Taiwan. Fishing News (Books) Ltd., London,160 pp.**
5. **Shigeno, K., 1978. Problems in Prawn Culture. Amerind Publishing Co. Pvt. Ltd.,New Delhi, 103 pp.**
6. **Gerwick, JR. B.C., 2007. Construction of Marine and Offshore Structures, CRC press,NewYork, 813 pp.**
7. **Grover, T.K., 2007. Basic Marine Engineering, Anmol, New Delhi, 275 pp.**
8. **Pandey, B.N., S. Deshpande and P.N. Pandey, 2007. Aquaculture, APH, New Delhi, 236pp.**
9. **Bhuejl, R.C., 2008. Statistics for Aquaculture, Wiley – Blackwell, New York, 222pp.**
10. **Holmer, M., 2008. Aquaculture in the ecosystem, Springer, Newyork, 326 pp.**
11. **Ramakrishnan, T.V., 2008. Offshore Engineering, Gene – Tech Books, New Delhi, 347.pp**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Land Survey.
CO2:	To understand the Fresh water and Coastal Aqua farm types.
CO3:	To understand the flow of water, water pipes, types of water pipes, feeding channels.
CO4:	To understand the types of Aerators used in Aquaculture.
CO5:	To view the types of soils and the characteristics of soil.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
3	3	3		3	3	
3	3	3		3	3	
			3	3	3	3
3	3		3	3	3	3

3	3	3	3	3	3	3
12	12	09	09	15	15	09

Semester- V **AQCP 506 – Practical – XVII(Covering AQCC 501)**

Credit: 1

Hours: 2

1. **Determination of physical characteristics of lentic water bodies.**
2. **Determination of chemical characteristics of lentic water bodies.**
3. **Determination of physical characteristics of lotic water bodies.**
4. **Determination of chemical characteristics of lotic water bodies.**
5. **Collection and identification of freshwater phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton.**
6. **Estimation of primary productivity in freshwater bodies. Collection and identification of freshwater zooplankton.**
7. **Enumeration and biomass estimation of zooplankton.**
8. **Collection and identification of benthos from lakhs, ponds, streams and canals. Enumeration and biomass estimation of benthos lakhs, ponds, streams and canals.**
9. **Collection and identification of nekton / aquatic insects from freshwater bodies.**
10. **Collection and identification of aquatic plants from different freshwater bodies. Methodology for collection and identification bacteria in freshwaters bodies. Enumeration and biomass estimation of bacteria in freshwater bodies.**

Semester- V **AQCP 507 – Practical – XVIII(Covering AQCC 502)**

Credit: 1

Hours: 2

1. **Collection of molluscan seed – materials, preparation and laying of spat collectors, observation of spat fall.**
2. **Identification of commercially important and cultivable molluscs of fresh, brackish and marine waters**
3. **Farm visit to witness seeding, growth, measurement, thinning, harvesting and in situ measurements of production.**
4. **Induction of spawning by physical, chemical and biological techniques.**

5. **Identification of commercially important and cultivable seaweeds.**
6. **Demonstration of algin and agar extraction.**
7. **Field visit to observe the culture of seaweeds and the technique of harvest.**
8. **Submission of field report.**

Semester- V AQCP 508 – Practical – IX(Covering AQCC 503)

Credit: 1

Hours: 2

1. **Evaluation of potential site for aquaculture.**
2. **Land survey - chain, compass, level, plane table, and contouring; soil analysis for farm construction.**
3. **Site survey: preparation of site and contour maps.**
4. **Design and layout of freshwater and brackish water farms and hatcheries.**
5. **Design of farm structure: ponds, dykes, sluices and channels.**
6. **Earth work calculation. Calculation on water requirement.**
7. **Pumps: design and operation.**
8. **Design and operation of filters and aerators.**
9. **Visit to different types of farms.**

Semester- V AQCP 509 – Practical – XX (Covering AQCC 504 & 505)

Credit: 1

Hours: 2

Any two practical based on Electives

PRACTICALFISH IMMUNOLOGY

Antigen-antibody reactions: Precipitation, agglutination. Immunodiagnostic assays - ELISA, western blot. Antigen preparation.Immunization of fish.Preparation of polyclonal antibody.Measurement of humoral immune response.Polyphenoloxidase assay.Haemocytecounts in shrimps.

PRACTICAL MARINE BIOLOGY

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, sea grasses, nekton and benthos.

PRACTICALAQUACULTURE IN RESERVOIR

1. **Preparation of charts on the present situation of reservoirs.**

2. **Estimation of reservoir fisheries productivity and diversity**

3. Detailed case studies of selected reservoirs

4. Analysis of data on reservoir fisheries.

5. Sustainable development plan for of reservoirs fisheries.

6. Designs, construction and types of cages and pens

6. Case studies on cage and pen culture culture in reservoirs.

7. Field visit to a 'cage culture unit'.

9. Field visit to a 'pen culture unit'.

10. Identification of candidate species for cage and pen culture

ELECTIVE -1FISH IMMUNOLOGY

Course Objectives

- **To understand the general concepts of immunology**
- **To study the immune mechanism and the immune-globulins**
- **To acquire knowledge on the immune response and the vaccine development**

Learning Outcomes

- ✓ **Clear understanding of immunology**
- ✓ **Clear knowledge on immune mechanism and the immune-globulins**
- ✓ **Complete knowledge on immune response and the vaccine development**

UNIT 1 -GENERAL CONCEPTS IN IMMUNOLOGY

Evolution of immune system in invertebrates and vertebrates.Non-specific defence mechanism in fish - surface barriers, non-specific humoral and cellular factors.

UNIT 2 –IMMUNE DEFENSE MECHANISMS

Leucocytes - types and function. Specific defence mechanism - lymphoid organs in fish.Ontogeny of fish immune system.B and T lymphocytes.

UNIT 3 – IMMUNOGLOBULIN

Immunoglobulin - types and function. Monoclonal and polyclonal antibodies.Primary and secondary immune response in fish - factors affecting.

UNIT 4 – IMMUNE RESPONSE

Immunological memory, Immunological tolerance.Stress and immune response.Defence mechanisms in crustaceans - humoral and cellular defenses.

UNIT 5 – DEVELOPMENT OF VACCINES

Principles of vaccination.Methods of vaccine development.Current trends in fish vaccination.Adjuvants and immuno-stimulants.

TEXT BOOKS

1. **Ellis AE. 1988. *Fish Vaccination.* Academic Press.**
2. **Iwama G and Nakanishi T. 1996. *The Fish Immune System. Organism, Pathogen and Environment.* Academic Press.**
3. **Janis K. 1997. *Immunology.* 3rd Ed. WH Freeman.**
4. **Swain P, Sahoo PK and Ayyappan S. 2005. *Fish and Shellfish Immunology: An Introduction.* Narendra Publ. House.**
5. **Murray RK, Granner DK, Mayes PA and Rodwell VW. 2003. *Harper's illustrated Biochemistry.* Appleton & Lange.**

REFERENCE BOOKS

1. **Iwama G and Nakanishi T. 1996. *The Fish Immune System. Organism, Pathogen and Environment.* Academic Press.**
2. **Van Oss CJ and Van Regenmortel MHV. 1994. *Immunochemistry.* CRC Press.**

ELECTIVE -IIMARINE BIOLOGY

Course Objectives

- **To understand the divisions in marine environment**
- **To study the primary producers and benthic ecosystem of ocean**
- **To study the diversity of nektons and marine mammals**

Learning Outcomes

- ✓ **Detailed knowledge on divisions in marine environment**
- ✓ **Clear knowledge on primary producers and benthic ecosystem of ocean**
- ✓ **Complete knowledge on diversity of nektons and marine mammals**

UNIT I INTRODUCTION:

Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton and zooplankton and sea weeds. Environmental factors affecting life in the oceans - salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide.

UNIT II PLANKTON

Primary, secondary and tertiary production.Marine food chains and food webs.Vertical migration of zooplankton Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, indicator species.Red tides,plankton and fisheries.

UNIT III BENTHOS

Life in rocky, sandy, and muddy shores.Mud banks.Mangroves and coral reefs.Boring and fouling organisms.

UNIT IV NEKTON

Outline composition of nekton, habitats of nekton. Bioluminescence.

UNIT V MARINE MAMMALS

Biology, significance and classification in mammals, adaptation in pinnipids and cetaceans for breeding.Whales- their different community and their characteristic features.Adaptations in marine mammals for conserving body heat and submersion for long dive.

TEXT BOOKS

1. **Balakrishnan Nair N and Thampy DM. 1980. *A Text Book of MarineEcology*. The MacMillan Co.**
2. **Castro P and Huber ME. 1997. *Marine Biology*. 2nd Ed. Mc-Graw Hill.**
3. **McCormick JM and Thiruvathaakal JV. 1976. *Elements of Oceanography*. WB Saunders.**
4. **Nybakken, J.W. 1997. *Marine Biology - An Ecological Approach*. 4th Ed. Addison Wesley.**
5. **Duxbury AC, Duxbury AB and Sverdrup KA. 2000. *An Introduction to the World's Oceans*. 6th Ed. McGraw Hill.**
6. **Sverdrup HV, Johnson MW and Fleming RH. 1959. *The Oceans – Their Physics, Chemistry and General Biology*. Prentice Hall**

REFERENCE BOOKS

1. **Gross G. 1993. *Oceanography: A View of the Earth*. 6th Ed. Prentice Hall.**
2. **Iversen ES. 1996. *Living Marine Resources*. Chapman & Hall.**
3. **Raymont, J.E.G. 1973. *Plankton and Productivity in the Oceans*. Pergamon Press.**

ELECTIVE -III AQUACULTURE IN RESERVOIR

Course Objectives

- **To understand the reservoirs of India**
- **To study the fish production and its management in reservoirs**
- **To study the cage, pen and essential infrastructures required for the aquaculture interventions in reservoir**

Learning Outcomes

- ✓ **Detailed knowledge on reservoirs and its characters**
- ✓ **Clear understanding of fish production trends and its management strategies**
- ✓ **Complete knowledge on cage, pen and infrastructures facilities for the interventions**

UNIT I INTRODUCTION

Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and post-impoundment stages and their significance in establishment of reservoirs fisheries.

UNIT II FISH PRODUCTION

Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production.

UNIT III FISHEIRES MANAGEMENT

Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs

UNIT IV CAGE AND PEN CULTURE

Role of cage and pen culture in enhancement of fish production from reservoirs; history of cage culture, advantages of cage culture; selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system. Integration of cage culture with other farming systems.

UNIT V INFRASTRUCTURE

History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture.

REFERENCE BOOKS

1. **Boopendranath, M.R., Meenakumari, B., Joseph, J., Sankar, T.V., Pravin,P., and Edwin, L. (Eds.) 2002, Riverine and ReservoirFisheries of India, Society of Fisheries Technologists (India), Cochin.**
2. **Brandt. A. v. (1984) Fish catching methods of the world. Fishing News Books Ltd., London: 432 p.**
3. **George V.C. (1971) An account of the inland fishing gears and methods of India. Spl. Bull.No.1.CIFT**
4. **Hameed, M.S. and Boopendranath, M.R. (2000) Modern Fishing Gear Technology, Daya Publishing House, Delhi:186 p.**
5. **Klust, G. (1982) Netting materials for fishing gear, FAO Fishing Manual, Fishing News Books (Ltd).,Farnham, 192p.**
6. **Sainsbury, J.C. (1986) Commercial fishing methods- An introduction to vessels and gear. Fishing News Books, Oxford: 208pp**
7. **Sreekrishna, Y. and Shenoy L. (2001) Fishing gear and craft technology, Indian Council of Agriculture**

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1	**3**	**3**	**3**		**3**	**3**	
CO2	**3**	**3**	**3**		**3**	**3**	
CO3				**3**	**3**	**3**	**3**
CO4	**3**	**3**		**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Total	**12**	**12**	**09**	**09**	**15**	**15**	**09**

Semester-VIAQCC 601ORNAMENTAL FISH BREEDING AND CULTURE

Credits: 4

Hours: 4

Course Objectives

- **To give overview on the potential ornamental fishes and their breeding biology**
- **To develop deep understanding about the various management practices for breeding and rearing of ornamental fishes**
- **To have a basic understanding of aquarium setting and aquarium infrastructures needed**

Learning Outcomes

- ✓ **Knowledge on the ornamental fish breeding**
- ✓ **Management practices of ornamental fishes**
- ✓ **Knowledge on the aquarium maintenance and accessories**

UNIT I INTRODUCTION

Introduction to aquarium, ornamental fishes and aquarium accessories- Aerators, filtersand lighting. World aquarium trade and present status.Design and construction of public fresh water and marine aquaria and oceanarium. Water quality management in aquarium fishes, Bio filters in aquarium.

UNIT II AQUARIUM MANAGEMENT

Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes, Quarantine measures.Aquarium maintenance and water

quality.Control of snail and algal growth.Handling, care and transportation of fish.Temperature acclimation, oxygen packing.

UNIT III FRESHWATER ORNAMENTAL FISHES

Species of ornamental fishes; their taxonomy and biology- Live bearers, Gold fish and koi, Gourami, Barbs and Tetras, angel fish, cichlids. Maturation, secondary sexual characters, breeding habits, spawning, parental are fertilization and development of eggs. Hatching, larval rearing and their health.Freshwater plants – their taxonomy and morphology, multiplication of aquarium plants –different methods.

UNIT IV MARINE ORNAMENTAL FISHES

Marine ornamental fishes – varieties and their habitat.Major marine ornamental fish resources of India.Method of collection of live fish.Breeding of marine ornamental fishes (clown fishes and Damsel fishes). Reef aquarium and live rocks. Other ornamental organisms – anemones, worms, lobsters, shrimps, octopus, starfish.

UNIT V ORNAMENTAL FISH DISEASE MANAGEMENT

Common parasites infecting ornamental fishes.Bacterial, viral, fungal diseases of ornamental fishes and their control and prophylaxis.

REFERENCE BOOKS

1. **Biswas, S. P., Das, J. N., Sarkar, U. K., &Lakra, W. S. (2007). Ornamental Fishes of North East India: An Atlas. ICAR, National Bureau of Fish Genetic Resources, Lucknow, India.**
2. **Spotte, S. (1973). Marine Aquarium Keeping: The Science, Animals and Art. John Wiley & Sons, New York.**
3. **Ramachandran, A. (2002). Manual on breeding, farming & management of ornamental fishes. School of Industrial Fisheries, Cochin, India.**
4. **Kurup, B. M., Harikrishnan, M., &Renjithkumar, C. R. (2012). Breeding farming and trade of ornamental fishes in India prospects and challenges. Souvenir-Ornamentals Kerala 2012.**
5. **Jhingran, V. G. (1975). Fish and fisheries of India.**
6. **Krishnakumar, K., Raghavan, R., Prasad, G., Bijukumar, A., Sekharan, M., Pereira, B., & Ali, A. (2009). When pets become pests–exotic aquarium fishes and biological invasions in Kerala, India. Current science, 97(4), 474-476.**
7. **Sirajudheen, T. K., Salim, S. S., Bijukumar, A., & Antony, B. (2014). Problems and prospects of marine ornamental fish trade in Kerala, India. J. Fish. Eco. Dev, 1151, 14-30.**
8. **Rath, R. K. (2018). Freshwater aquaculture. Scientific Publishers.**

9. Santhanam, R., Sukumaran, N., & Natarajan, P. (1990). A Manual of Fresh-Water Aquaculture, p: 10–11. Published by Modern Primlani for Oxford and IBH Publishing Co., Pvt. Ltd, 66.
10. Santhanam, R., Sukumaran, N., & Natarajan, P. (1987). Manual of fresh-water aquaculture. Oxford & IBH Publishing.
11. Murty, V. S. (2002). Marine ornamental fish resources of Lakshadweep. CMFRI special publication, 72, 1-134.
12. Bunting, B. W., Holthus, P., & Spalding, S. (2003). The marine aquarium industry and reef conservation. Marine Ornamental Species: Collection, Culture, and Conservation, 109-124.
13. Olivier, K. (2003). World trade in ornamental species (pp. 49-63). Iowa State Press: Ames.
14. Cato, J. C., & Brown, C. L. (Eds.). (2008). Marine ornamental species: collection, culture and conservation. John Wiley & Sons.
15. Woo, P. T., Leatherland, J. F., & Bruno, D. W. (Eds.). (2006). Fish diseases and disorders (Vol. 3). CABI.
16. Bardach, J. E., Ryther, J. H., &McLarney, W. O. (1972). Aquaculture. The farming and husbandry of freshwater and marine organisms. John Wiley & Sons, Inc.
17. Stickney, R. R. (1979). Principles of warm water aquaculture. John Wiley & Sons.
18. Billard, R. (1981). Hypophysation of Indian major carps: SL Chondar. Satish Book Enterprise, Motihatra, Agra 3, India, 1980, 146 pp.
19. Jhingran, V. G. (1991). Fish and Fisheries of India, Hindustan Publ. Co. New Delhi, 727.
20. Santhanam, R., Sukumaran, N., & Natarajan, P. (1987). Manual of fresh-water aquaculture. Oxford & IBH Publishing.
21. Pillay, T. V. R., &Kutty, M. N. (2005). Aquaculture: principles and practices (No. Ed. 2). Blackwell publishing.
22. Pandey, A. C. (1990). Air Breathing Fishes. Reliance Publishing House.
23. Rao, K. J. (1998). Emerging Technology on the Seed fish Production of *Macrobrachiumrosenbergii*. In Current and Emerging Trends in Acquaculture: Proceedings of the National Seminar on Current and Emerging Trends in Aquaculture and Its Impact on Rural Development, 14-16 February 1995 (Vol. 1, No. 2, p. 164). Daya Books.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Introduction to Aquarium, Ornamental and Aquarium accessories.
CO2:	To understand the Setting up of an Aquarium and Aquarium management practices.
CO3:	To understand the Fresh water ornamental fishes, Culture and Breeding.
CO4:	To understand the Marine Ornamental Fishes, Culture and Breeding.
CO5:	To view the common parasites affecting ornamental fishes, bacterial fishes and disease management.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3			3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	

CO3				3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester-VIAQCC 602AQUACULTURE EXTENSION AND ECONOMICS

Credits: 4

Hours: 4

Course Objectives

- **To give overview on the potential ornamental fishes and their breeding biology**
- **To develop deep understanding about the various management practices for breeding and rearing of ornamental fishes**
- **To have a basic understanding of aquarium setting and aquarium infrastructures needed**

Learning Outcomes

- ✓ **Knowledge on the ornamental fish breeding**
- ✓ **Management practices of ornamental fishes**
- ✓ **Knowledge on the aquarium maintenance and accessories**

UNIT I INTRODUCTION

Extension education, capture fisheries and culture fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of capture and culture fisheries extension in fisheries sector development.

UNIT II EXTENSION STRATEGIES AND METHODS

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; theories of learning, learning experience, learning situation.Culture and capture fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and

use.

UNIT IIITECHNOLOGY TRANSFER

Characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of BFDA, FFDA, MPEDA, CAA, NGOS and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations.

UNIT IV MARKETING

Markets and their kinds.Law of demand and supply, price determination, problems of fish marketing in India.Exports of fish and fishery products, trends and problems- Anti-dumping.Role of MPEDA in exports of fish and fishery products.

UNIT V ECONOMICS

Definition, subject matter and scope of economics. Law of diminishing returns, laws of increasing, constant and decreasing utility and returns. Law of equi-marginal returns.Importance of economics in aquaculture development.GDP from fisheries and aquaculture sector, foreign exchange earnings and employment potential of fishery and aquaculture industry.

TEXT BOOKS

1. **Sharma Op, and LlSomani , 2012.Fundamentals of Rural Sociology & Educational Psychology ISBN: EBK0295955 Publisher: Agrotech Publishing Academy,Delhi**
2. **Adivi Reddy, A. 2001. Extension Education. Sri Lakshmi Press, Bapatla.**
3. **Chitamber, J.B. 1997. Introductory Rural Sociology. Wiley Eastern Limited, New Delhi.**
4. **Daivadeenam, P. 2002. Educational Psychology in Agriculture. Agrotech Publishing Academy, Udaipur.**
5. **Mangal, S.K. 2000. Educational Psychology. Prakash Brothers, Ludhiana.**
6. **Ray, G.L. 2006. Extension Communication and Management. NayaPrakashan, Kolkata.**
7. **Vidyabhushan and Sach Dev, D.R. 1998. An Introduction to Sociology. KitabMahal Agencies, Allahabad.**
8. **Cunningham S, Dunn MR and Whitmarsh D. 1985. *Fisheries Economics: An introduction*St.Martin's Press**
9. **Chitambar JB. 1990. *Introductory Rural Sociology*. Wiley Eastern.**
10. **Haralambos M, Heald RM and Holborn M. 1995. Sociology: Themes and Perspectives. Collins Educ.**
11. **Morgan CT and King RA. 1975. Introduction to Psychology. Tata McGrawHill.**
12. **Sinha VRP. 1999. Rural Aquaculture in India. FAO, United Nations,Thailand. RAP Publ.**
13. **Farming Freshwater Prawns. A Manual for the Culture of the Giant River Prawn *(Macrobrachiumrosenbergii)*. 2004. FAO Fisheries Tech.Paper No. 428, Rome.**

REFERENCE BOOKS

1. **Loretta S. 2005. *Good Agricultural Practices Standards: A Way towards Safe and Sustainable Agriculture*? Seminar on Certification andRegulations for Food Safety, 31 May 2005, Wageningen.**
2. **Scott M. 2001. *Distance Education and Distance Learning: A Framework for the Food and Agriculture Organization of the United Nations*.Sustainable Development Department, FAO.**

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the Introduction to Extension Education.
CO2:	To understand the Extension strategies and methods.
CO3:	To understand the characteristics of Technology Transfer FFDA, BFDA.
CO4:	To understand the Markets and their kinds, importance of MPEDA in Exports and Imports.
CO5:	To view the definition and strategies of economics, Law of demand etc.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3			3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3				3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	

CO3				3	3	3	3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester- VI AQCP 605 – Practical – XXI(Covering AQCC 601)

Credit: 1

Hours: 2

1. **Identification of common Fresh water aquarium fishes (20 Nos).**
2. **Identification of common Brackish and marine aquarium fishes (20 Nos). Construction of aquarium.**
3. **Setting up of aquarium (maintained by students can be evaluated after one month). Water quality management in quariums.**
4. **Aquarium plants and décor materials.**
5. **Air pump and biological filter.**
6. **Breeding of live bearers-Guppy.**
7. **Breeding of egg layers- gold fishes**
8. **Breeding of bubble nest builder- Gourami.**

Semester- VI AQCP 605 – Practical – XXII(Covering AQCC 602)

Credit: 1

Hours: 2

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non - governmental organizations through stakeholder analysis; case studies on social / gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories Practical exercises on conducting fish farmers meet. Visit of fishermen co-operative society.Visit to aquaculture

farms. Income and CBR statement analysis. Preparation of proposal for loan from commercial bank including plan, budget and repayment schedule Radio-talk, video talk, leaflets, folders, pamphlets, circular letter, poster, charts etc. for aquaculture Training to get license, Subsidy and from the Government and banks Submission of field report.

Semester- VI AQCP 606– Practical – XXIII (Covering AQCC 603 & 604)

Credit: 1

Hours: 2

Any two practical based on Electives

PRACTICAL FISH MICROBIOLOGY AND QUALITY ASSURANCE

Study of micro-organisms associated with finfish and shellfish. Spoilage micro-organisms. Isolation of pathogenic bacteria associated with fish and fishery products -*Vibrio, E coli, Salmonella, Listeria, Clostridia, Campylobacter*, *Streptococcus*, Fecal *Streptococcus*, etc. Effect of chemical and physical preservatives on spoilage organisms.Conventional and rapid methods for detection of microorganisms. Biochemical tests for characterization of bacteria. Assessment of sanitation in fish processing plants, Indices of freshness and quality of fresh and processed fish.Sensory evaluation, hedonic scale, physical and chemical methods of assessment of quality of fish and fishery products.Determination of available chlorine. Visit to factory & Study of Hazard analysis Critical Control Point (HACCP) system and its implementation

PRACTICAL DISEASE MANAGEMENT IN AQUACULTURE

Methods of sampling fish and shellfish for disease diagnosis. Live and post mortem examination of diseased fin and shell fish. Collection and identification of parasites (Isopod, Nematode, copepod-fish lice- Lernea) from fin and shell fishes.Morphological, biochemical and biological tests of bacteria, virus and fungi.Immunological and molecular disease diagnostic techniques. Antibiotic sensitivity assays. WSSV infectivity study. Shrimp black gill disease. Healthy shell and fin

fish seed identification. Probiotics, Antibiotics, disinfectants, limes, medicated feeds, Anti-bacterial, antiviral and antifungal drugs in the market. Aqua-shop visit.

PRACTICAL FISH PRESERVATION TECHNOLOGY

1. **Determination of moisture content in fish and fishery products**
2. **General description – freezing**
3. **Processing of shrimp**
4. **Filleting of fish**
5. **Drying of fish**
6. **Organoleptic analysis of fish**
7. **Preparation of fishery by products**
8. **Preparation of shark fin rays fish maws, chitin, fish wafer**
9. **Fish pickling**
10. **Value added fishery products, fish curry, cutlets fish finger.**
11. **Preparation of surimi**

ELECTIVE-I FISH MICROBIOLOGY AND QUALITY ASSURANCE

Course Objectives

- **To give overview on the history and importance of microorganisms in fish foods**
- **To develop deep understanding on intrinsic, extrinsic and food borne pathogens**
- **To have a basic understanding of fish spoilage and fish processing plant sanitation**

Learning Outcomes

- ✓ **Knowledge on the history and importance of microorganisms in fish foods**
- ✓ **Detailed knowledge on intrinsic, extrinsic and food borne pathogens**
- ✓ **Knowledge on fish spoilage and fish processing plant sanitation**

UNIT IINTRODUCTION

History of micro-organisms in foods; role and significance of micro- organisms in nature and in foods.

UNIT II MICRO-ORGANISMS IN FISH

Intrinsic and extrinsic parameters of fish that affect microbial growth.Psychrophiles, halophiles and thermophiles, their role in spoilage and food poisoning.

UNIT III FOOD BORNE HUMAN PATHOGENS

Vibrio, E coli, Salmonella, Listeria, Clostridia, Campylobacter, Streptococcus, Faecal Streptococcus, etc.Study of micro-organisms in food by conventional and rapid techniques. Encapsulation - endospores, formation of cell aggregates, Microbial principles of fish preservation and processing. Study of food pathogens, infections, intoxication and other biological hazards like mycotoxins, parasites, viruses, marine toxins, etc.

UNIT IV FISH SPOILAGE

Types of spoilage of fish, semi processed and processed fishery products, Indices of fish sanitary quality, Concept of Quality Management; TQM, SSOP, GMP; ISO and Codex Alimentarius; HACCP, Microbiological standards and criteria, BIS and codex standards

for fish and fishery products. Process water quality.

UNIT V FISH PLANT SANITATION .

Disinfectants, detergents and cleaning schedule. CIP, Water management in fish processing industries.

TEXT BOOKS

1. **Anthony TT. 1988. *Handbook of Natural Toxins. Marine Toxins and Venom.* Vol. III. Marcel Dekker.**
2. **Balachandran KK. 2001. *Post-Harvest Technology of Fish and Fish Products.* Daya Publ. House.**
3. **Kreuzer R. 1971. *Fish Inspection and Quality Control.* Fishing News.**
4. **Connell JJ. 1995. *Control of Fish Quality.* Fishing News Books.**

REFERENCE BOOKS

1. **Fennema K, Powrie WD and Marth EH. 1973. *Low Temperature Preservation of Foods and Living Matter.* Marcel Dekker.**
2. **Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology.*ICAR.**
3. **Hall GM. (Ed). 1992. *Fish Processing Technology.* Blackie.**
4. **Hui YH, Merle DP and Richard GJ. (Eds.). 2001. *Food Borne Disease***
5. ***Handbook. Seafood and Environmental Toxins.* Vol. IV. Marcel Dekker.**

ELECTIVE-IIDISEASE MANAGEMENT IN AQUACULTURE

Course Objectives

- **To give overview on diseases in aquaculture and its mechanisms**
- **To develop deep understanding on protozoan, bacterial, viral and fungal diseases in aquaculture system**
- **To have a basic understanding on the nutritional, parasitic and its preventive measures**

Learning Outcomes

- ✓ **Detailed insights in to diseases in aquaculture and its mechanism**
- ✓ **Clear knowledge on protozoan, bacterial, viral and fungal diseases in aquaculture system**
- ✓ **Knowledge on nutritional, parasitic and its preventive measures**

UNIT I FISH DISEASE IN AQUACULTURE

Significance of fish diseases in relation to aquaculture.Disease development process in fish and shellfish.Defense mechanism in finfish and shellfish- specific and non specific immune system.Role of stress and host defense mechanism in disease development.Host, pathogen and environment interaction.Zoonotic diseases. OIE

UNIT II PROTOZOAN AND BACTERIAL DISEASS

Protozoan diseases (finfish) –Ichthyophthiriasis, Costiasis, whirling diseases, trypanosomiasis. Shrimp diseases – Microsporidiosis, Gregaria disease, ecto-comensal protozoan. Bacterial disease (finfish) – furunculosis, columnaris, bacterial gill disease, gill rot, Enteroredmouts, Edwardsiellosis, vibriosis, tail and fin rot, EUS. Shrimp disease – brown spot, black gill, filamentous bacterial disease, luminous vibriosis.

UNIT IIIFUNGAL AND VIRAL DISEASES

Fungal diseases (finfish) – Saprolegniosis, brachiomycosis, ichthyophorus diseases – Lagenidium diseases – Fusarium disease Viral diseases (finfish) – IPN, IHN, Viral Hemorrhagic Septicemia, Spring Viremia of carps – Major CCVD, Carp lymphocytes – Major shrimp viral diseases – *Bacculoviruspenaeii*, MonodonBacculovirus, Bacculoviralmidgut necrosis, IHHNV, Hepatopancreaticparvo like virus, Yellow head bacculovirus, white spot bacculovirus and , White faeces syndrome.
Loose shells syndrome

UNIT IV NUTRITIONAL AND PARASITIC DISEASES

Nutritional pathology – lipid liver degeneration , deficiency diseases due to vitamin A,D,E,K, B-Complex, C, pantothenic acid, folic acid, biotin, choline, minerals. Aflatoxin and dinoflagellates.Antibiotic and chemotherapentants.Nutritional cataract.Genetically and environmentally induced diseases, loose shells syndrome.Morphology, biology and life cycle of parasites (Isopods, copepods, Parasitic diseases (Isopod, copepod, nematode, Trematode, Acanthocephalans) - General characteristics, Epizootiology, Diagnosis, Life cycle, Prevention and treatment.

UNIT V DISEASE MANAGEMENT AND PREVENTION

Microscopical, microbiological, histopathological and biochemical methods. Antibody and nucleic acid based rapid diagnostics. Case history and clinical sign in diagnosis.Conventional and rapid diagnostic techniques.Drugs, chemicals, antibiotics, prebiotics and probiotics used in aquaculture and their mode of action.Principles and methods of vaccine production and fish immunization.Crop rotation, Immunostimulants, bioremediation and polyculture as strategies for health management. Bio-floc based aquaculture. General preventive methods and prophylaxis against the occurrence of diseases. Good pond management practices- Eco-friendly and sustainable aquaculture. Production of disease-free seeds. Zero water exchange. Quarantine and health certification in aquaculture..SPF and SPR seeds and brooders.

TEXT BOOKS

1. **Andrews C, Excell A and Carrington N. 1988. *The Manual of Fish Health.* Salamander Books.**
2. **Sindermann CJ. 1990. *Principal Diseases of Marine Fish and Shellfish.* Vols. I, II. 2nd Ed. Academic Press.**
3. **Schaperclaus W. 1986. *Fish Diseases.* Vols. I, II. Oxonian Press.**
4. **Jorge E, Helmut S, Thomas W and Kapoor BG. 2008. *Fish Diseases.*Science Publ.**
5. **Felix S, Riji John K, Prince Jeyaseelan MJ &Sundararaj V. 2001. *Fish Disease Diagnosis and Health Management.* Fisheries College andResearch, Institute, T. N. Veterinary and Animal SciencesUniversity. Thoothukkudi.**
6. **Humphrey J, Arthur JR, Subasinghe RP and Phillips MJ. 2005. *Aquatic Animal Quarantine and Health Certification in Asia.* FAO Publ.**

REFERENCE BOOKS

1. **Inglis V, Roberts RJ and Bromage NR. 1993. *Bacterial Diseases of Fish.* Blackwell.**
2. **Iwama G and Nakanishi T. (Eds.). 1996. *The Fish Immune System Organism, Pathogen and Environment.* Academic Press.**
3. **Roberts RJ. 2001. *Fish Pathology.* 3nd Ed. WB Saunders.**
4. **Shankar KM and Mohan CV. 2002. *Fish and Shellfish HealthManagement.*UNESCO Publ.**
5. **Wedmeyer G, Meyer FP and Smith L. 1999. *Environmental Stress and Fish Diseases.* Narendra Publ. House.**

6. **Woo PTK and Bruno DW. (Eds.). 1999. *Fish Diseases and Disorders*. Vol. III. *Viral, Bacterial and Fungal Infection*. CABI...**
Walker P and Subasinghe RP. (Eds.). 2005.

ELECTIVE III FISH **PRESERVATION TECHNOLOGY**

Course Objectives

- **To familiarize fish handling, chilling and freezing**
- **To develop deep understanding on drying, smoking,canning and freeze drying**
- **To have a basic understanding on quality control, by-product, packing and export of fish foods**

Learning Outcomes

- ✓ **Detailed insights in to fish handling, chilling and freezing**
- ✓ **Clear knowledge on drying, smoking,canning and freeze drying**
- ✓ **Knowledge on quality control, by-product, packing and export of fish foods**

UNIT I FISH HANDLING, CHILLING AND FREEZING

Common fishes, shrimps and mollucs landed and processed in Kerala. Handling of fish on board, in the landing center and processing centre.Design and layout of preprocessing and processing centers.Icing of fish, different types of ice, quality of ice. Fundamental principles involved in chilling and freezing of fish and fishery products. Various freezing methods.RSW/CSW systems.Changes during freezing and frozen storage.

UNIT II DRYING, SMOKING, CANNING AND FREEZE-DRYING

Principles of drying and salting of fish, factors affecting drying.Traditional drying / curing methods.Packing and storage of dried products.Principles of freeze drying. Principles involved in canning of fish. Different stages of canning of fish/prawn. Retortable pouch processing.Spoilage of canned products. Cut open test and commercial sterility and quality examination of canned products.

UNIT III QUALITY CONTROL IN SEA FOOD PROCESSING

Concept of quality in fish and fishery products.Organoleptic analysis of fish and fishery products.Microbiological analysis of fish and fishery products.TPC and MPN of coliforms in

sea food.*Salmonella, Vibrio, Staphylococcus* and *E. coli* in sea food.Quality standards for sea food.

UNIT IVFISHERY BY-PRODUCTS

Fish meal and fish oil.Different methods of production of fish oils and their uses. Different grades of fish meal. Nutritional significance of fish oil.Chitin and chitosan.Fish silage-production and uses. Shark fin rays, gelatin, squalene, beche-de-mer, carrageenan, agar.

UNIT VPACKING, COLD STORAGE AND EXPORT OF FISHERY PRODUCTS

Functions of packing. Different types of packing materials and its quality evaluation. Packing requirements for frozen and cured products.Statutory requirements for packing.Labelling requirements.Different type of cold storages.Requirements in retail outlet.Insulated and refrigerated vehicles. Export of marine products. Role of MPEDA and EIA in export promotion and quality control.

TEXT BOOKS

1. **Balachandran KK. 2002. *Fish Canning Principles and Practices*. CIFT,Cochin.**
2. **Gopakumar K. 2002. *Text Book of Fish Processing Technology*. ICAR.**
3. **Hall GM. (Ed). 1992. *Fish Processing Technology*. Blackie.**
4. **Hersom AC and Hulland ED. 1980. *Canned Foods*. Chemical Publ. Co.**
5. **Larousse J and Brown BE. 1997. *Food Canning Technology*. Wiley VCH.**

REFERENCE BOOKS

1. **Nambudiri DD. 2006. *Technology of Fishery Products*. Fishing Chimes.**
2. **Stumbo. 1973. *Thermo Bacteriology in Food Processing*. CRC, AcademicPress.**
3. **Thorne S. 1991. *Food Irradiation*. Elsevier.**
4. **Venugopal V. 2006. *Seafood Processing*. Taylor & Francis.**
5. **Warne D. 1988. *Manual on Fish Canning*. FAO Fisheries Tech. Paper 285.**
6. **Zeathen P. 1984. *Thermal Processing and Quality of Foods*. Elsevier.**
7. **Joshy CD and Devadhason M. 2001. *Basic Electronics and Fish Finding Equipments*. CIFNET, Cochin.**
6. **Shawyer M and Pizzali AFM. 2003. *The Use of Ice on Small Fishing Vessels*. FAO Tech. Paper No. 436. Rome.**

CO-PO MAPPING SCORES

Courses Impact	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
1	15	15	09	09	15	15	09
2	12	09	09	09	15	09	06
3	15	15	09	09	09	09	09
4	15	09	09	09	09	09	09
5	09	12	09	09	15	12	09
6	12	12	09	09	15	15	09
7	15	15	09	09	15	15	09
8	12	15	09	09	15	15	09
9	12	12	09	09	15	15	09
10	15	15	06	06	12	15	09
11	12	12	06	09	15	12	06
12	15	15	09	09	12	12	06
13	15	15	09	09	15	15	09
14	12	15	09	09	15	09	09
15	12	12	09	09	15	15	09
Total Score	198	198	129	132	207	192	126