Annamalai University
(Accredited with 'A' Grade by NAAC)

COASTAL AQUACULTURE
(Two – Year) Programme

Regulations & Curriculum 2019-2020

CAS in Marine Biology
FACULTY OF MARINE SCIENCES

ANNAMALAI UNIVERSITY

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

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculty of Marine Sciences from the academic year 2019-2020 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 higher education in Coastal Aquaculture

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

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 is an 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	
M.Sc. Coastal Aquaculture	A Under Graduate degree in Zoology/ Botany/ Plant Biology & Plant Biotechnology / Plant Science / Animal Science/ Animal Science & Biotechnology / Animal Biotechnology / Advanced Zoology & Biotechnology / Biochemistry / Industrial Fish and Fisheries / Microbiology / Environmental Science / Chemistry or B.F.Sc./B.Sc. Agriculture / B.Voc. Aquaculture / Commercial Aquaculture / Industrial Aquaculture or any UGC Kaushal Kendra supported UG degree in Aquaculture or Fisheries, B.Sc. Biotechnology or B.Tech. Biotechnology / Genetic Engineering with a minimum of 50% marks in Part-III

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 Two Year Master's Programmes consist of two 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 Two Year Master's Programme 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 **Interdepartment 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 (as applicable) fall under this category

5.4.3 Experimental learning is categorised 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 organized as follows:

	Credits
Core Courses	65-75
Elective courses	15
Project	6-8
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 organisation 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 such as NET/SET, GATE etc., 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 course(s) 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

9.2.3 For 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 Department(s) 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 Master'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 Master'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 passed in 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.~~

Annamalai University
Department of CAS in Marine Biology
M.Sc. Coastal Aquaculture (Two Year) Programme
Programme Code:
Programme Structure
(For students admitted from the academic year 2019-2020)

Course Code	Course Title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19CAQC 101	Fundamentals of Marine Biology and Oceanography	4		4	25	75	100
19 CAQC 102	Nutrition and Biochemistry	3		3	25	75	100
19 CAQC 103	Physiology, Cytology and Genetics	4		4	25	75	100
19 CAQC 104	Aquaculture Engineering	3		3	25	75	100
19 CAQC105	Aquarium Keeping and Management	3		3	25	75	100
19 CAQE 106	Elective – I (IDE)	3		3	25	75	100
19 CAQP 107	Practical – I (19CAQC 101, 104& 105)		6	3	40	60	100
19 CAQP 108	Practical – II (19 CAQC 102& 103)		4	2	40	60	100
				25			
Semester-II							
19CAQC201	Biology and Culture of Crustaceans	3		3	25	75	100
19 CAQC202	Biology and Culture of Finfishes	3		3	25	75	100
19CAQC203	Biology and Culture of Mollluscs and Seaweeds	3		3	25	75	100
19CAQC204	Health management in Aquaculture systems	3		3	25	75	100
19CAQC205	Post Harvest Technology	4		4	25	75	100
19 CAQP206	Practical – III (19CAQC 201)		2	1	40	60	100
19 CAQP207	Practical – IV (19CAQC 202& 203)		6	3	40	60	100
19 CAQP208	Practical – V (19CAQC 204 & 205)		6	3	40	60	100
				23			
Semester-III							
19CAQC301	Instrumentation and Analytical Methods	4		4	25	75	100
19CAQC302	Biotechnology and Applied Marine Biology	4		4	25	75	100
19CAQC303	Aquaculture Information,	4		4	25	75	100

	Economics & Extension						
19CAQC304	Bioentrepreneurship	4		4	25	75	100
19CAQE305	Elective – II (DE)	3		3	25	75	100
19CAQE306	Elective – III (DE)	3		3	25	75	100
19CAQP307	Practical – VI (19CAQC 301& 303)		6	3	40	60	100
19CAQP308	Practical – VII (19CAQC 302)		2	1	40	60	100
				26			
Semester-IV							
19CAQC401	Plant and Animal cell Culture Technology	4		4	25	75	100
19CAQE402	Elective – IV (DE)	3		3	25	75	100
19CAQE403	Elective – V (DE)	3		3	25	75	100
19CAQP404	Project Work			8	30	70	100
				18			
	Total Credits			**92**			
	Value Added Courses						
	On-line courses (SWAYAM, MOOC and NPTEL)						

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.
2. Students may opt for any Value-added Courses listed in the University website.

Elective Courses

Department Electives (DE)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
19CAQE 305	**Disaster Management**	**3**		**3**	**25**	**75**	**100**
19CAQE 306	**Marine Food Technology**	**3**		**3**	**25**	**75**	**100**
19CAQE 402	**Microbial Technology**	**3**		**3**	**25**	**75**	**100**
19CAQE 403	**Remote Sensing**	**3**		**3**	**25**	**75**	**100**

Inter Departmental Electives (IDE)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
19CAQE 106	**Soft Skill Development**	**3**		**3**	**25**	**75**	**100**

Programme Outcomes

PO1:	The Faculty of Marine Sciences will endeavor to continue a master program in Coastal 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 Master degree in Coastal Aquaculture will be skilled in the advance level of marine sciences.
PO4:	Students graduating with a Master degree in Coastal Aquaculture will be trained to involve in research program and other job opportunities.
PO5:	Students graduating in Coastal Aquaculture with master level dissertation work/pre research experience will ensure their future become a Scientist, R&D experts, teachers and field experts.

Programme Specific Outcomes

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

PSO1:	Impart complete knowledge about the fundamentals of Marine Sciences including the Farm Engineering, Biology of cultivable species, marketing techniques.
PSO2:	Explore the basics of aquarium keeping and management
PSO3:	Teach the physiology, cytology and genetics discipline to some extent
PSO4:	Gain knowledge on the taxonomy of marine organisms by using the both conventional and molecular methods.
PSO5:	Preparing the students not only on the biological information and train the various techniques/instruments viz., Knudesen sampler, Bathy meter, hydrometer, Seichi disc, Spectrometer, Gel Doc, HPLC, FTIR etc.
PSO6:	Carrying out various experiments for water quality; enumerate the primary producers, monitoring the marine pollution, biodegradation, probe development and microbial identification.
PSO7:	Practicing the students with proficient in culture of marine organisms, utilization of marine resources, to learn food technology aspects.

SEMESTER I

19CAQC101 : FUNDAMENTALS OF MARINE BIOLOGY AND OCEANOGRAPHY

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To learn various coastal environment i.e., marine, brackish, estuarine, mangroves, lagoons and coral reefs. To distinguish various physico – chemical features related to these coastal environments.
LO2: To learn about the basic concepts of physical, chemical and biological oceanography.
LO3: To understand the classification, method of collection, analysis and biomass estimation of plankton. To gather knowledge on the planktonic blooms, primary production, carbon Sequestration by marine algae.
LO4: To know the classification of benthos and their various adaptations to varied habitats.
LO5: To glean knowledge about living and non-living resources of marine environment and to learn various types of marine pollution.

UNIT I: Ocean – General

Classification of coastal environment – marine, brackish, estuarine, mangroves, lagoons and coral reefs – their physico – chemical features.

UNIT II: Oceanography

Basic concepts in physical, chemical and biological oceanography. Sea as a biological environment.

UNIT III: Plankton

Classification of plankton, methods of collection, preservation, analysis and biomass of phytoplankton and zooplankton. Phytoplankton blooms, primary production – methods of estimation. Carbon Sequestration by marine algae.

UNIT IV: Benthos

Benthos – classification, methods of sampling and biomass estimation, adaptations of benthic forms.

UNIT V: Resources - Pollution

Resources of marine environment – commercially important finfish, shellfish, algal resources – Non- living resources – minerals, salts, petroleum and natural gas, Drug from the seas.

Marine pollution types – sewage, hydrocarbons, pesticides, heavy metals, thermal, oil radioactivity.

Practical

1. Phytoplankton – Methods of collection, identification of common forms, estimation of standing crop and primary production, Methods of estimation.

2. Zooplankton – collection, estimation, identification of major groups and biomass analysis.
3. Benthos – collection, qualitative and biomass analyses
4. Analyses of water qualities
   Salinity
   Dissolved Oxygen
   Nutrients
   pH
   BOD and COD
   H^2S and
   Ammonia
5. Identification of commercially important fin and shell fishes, algae especially medicinally
   important algae, mangroves, animals etc (Snakes, Corals, Sponges etc).

REFERENCE BOOKS

1. Iversen, E.S., 1996. Living Marine Resources. Chapman and Hall, New York, 403 pp.
2. Castro, P. and M.E. Huber, 1997. Marine Biology, Second Edition. Mc-Graw Hill Company, New York, 450 pp.
3. Nybakken, J.W., 1997. Marine Biology – An Ecological Approach. Fourth Edition. Addison Wesley Edu. Pub. Inc, California, USA, 481 pp.
4. Kenneth Sherman, 1998.Large marine ecosystems of the Indian Ocean, Blackwell science-USA, 394pp.
5. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction to the World's Oceans. 6th Edition. McGraw Hill Company Inc, New York 528 pp.
6. Michael. H. Glantz, 2001. Currents of change, second edition. Cambridge university press, UK, 252pp.
7. Jeffrey S. Levinton, 2001. "Cd marine biology: function, biodiversity, ecology with CD-ROM" Publishing Oxford University Press, New York, 515pp.
8. Ravi Mishra, 2002. Marine environment. Anmol publications, New Delhi, 299pp.
9. Mitra, A., K. Banerjee and A. Gangopadhyay, 2004. Introduction to marine plankton, Daya Publishing House, New Delhi, 97 pp.
10. Srivastava.,M.M. and Rashni Sanghi, 2007. Chemistry of green environment. Narosa Publications New Delhi, 364 pp.

Course Outcomes

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

CO1:	Understand the classification of various coastal environments and their physico – chemical characteristics.
CO2:	Understand basic concepts in physical, chemical and biological oceanography.
CO3:	Comprehend the classification, method of collection, analysis and biomass estimation of Plankton- bloom forming plankton, primary production and Carbon sequestration of marine plankton
CO4:	Know the classification and importance of Phylum Mollusca.

CO5:	To have thorough understanding on the living and non-living resources of marine environment besides to know various types of marine pollution.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3		3				3	3	
CO 2	3		3			3		3			3	
CO 3	3	3	3		3	3			3		3	3
CO 4	3		3		3	3			3	3	3	3
CO 5	3		3	3	3	3		3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3				3	3	
CO2	3		3			3	
CO3	3			3		3	3
CO4	3			3	3	3	3
CO5	3		3	3	3	3	3
Total	15		6	9	9	15	9

SEMESTER I
19CAQC 102 –NUTRITION AND BIOCHEMISTRY

Credits – 3
Hours: 3

Learning Objective (LO):

LO1: To learn aquaculture nutrition and importance of various ingredients in the nutrition of fin and shellfish.
LO2: To know various feed ingredients used in fish feed preparation and formulation.
LO3: To understand various types of feed used in aquaculture and feed storage.
LO4: To learn about the different types of live feed used in aquaculture and their mass scale production.
LO5: To glean knowledge on the carbohydrate, protein, fat and enzymes.

UNIT 1: Nutrition

Aquaculture nutrition - an Overview, proteins, amino acids, lipids and fatty acids, carbohydrates and carotenoids - their importance in the nutrition of fin and shellfish, role of vitamins and minerals.

UNIT 2: Feed ingredients and feed formulation

Ingredients – conventional and non – conventional, their nutritive value, feed formulation methods, binders, water stability of feed, use of attractants in feeds, importance of anabolic agents – antioxidants and mould inhibitors, anti – nutritional factors – other additives.

UNIT 3: Types of Feed, Feed storage and evolution

Different types of formulated feeds – pellets - dry feed, wet feed, floating feed, lakes, micro particulate and microencapsulated diets, storage and quality control. Determination of energy content in feeds, FCR and energy budget.

UNIT 4: Live feed

Methods of collection of live food organisms, identification, isolation and maintenance of phytoplankton, mass culture of phytoplankton and zooplankton (*Brachionus, Copepods* and *Moina*), culture of *Artemia*, production of cyst and their utilization.

UNIT 5: Biochemistry

Carbohydrate, protein and fat; enzymes – classification, factors influencing enzyme activity, role of enzyme in food processing.

Practical

1. Formulation and preparation of artificial feeds for finfish and shrimps
2. Determination of food intake and digestibility coefficient
3. Culture of live – feed organisms (Phytoplankton and zooplankton)

4. Estimation of the following in the feed ingredients and feeds:
   Carbohydrates by Colorimetric method
   Proteins by Colorimetric method
   Use of Spectrometer
5. Chromatographic separation of free aminoacids and carbohydrates by ascending, descending and circular paper chromatographic techniques
6. Chromatographic separation of lipids by T.L.C.
7. Estimation of moisture and lipid content
8. Electrophoretic separation of protein

REFERENCE BOOKS

1. Albert L. Lehninger, David L. Nelson and Michael M. Cox, 1993. Principles of Biochemistry, CBS Pub. & Distributors, New Delhi. 1013 pp.
2. Sena S. De Silva and Trever A. Anderson, 1995. Fish Nutrition in Aquaculture, Chapman & Hall, London, 319 pp.
3. Wedemeyer Gary, A., 1996. Physiology of Fish in Intensive Culture Systems. Champman & Hall, London, 232 pp.
4. Bardach, John E., 1997. Sustainable Aquaculture. John Wiley & Sons Inc., New York, 251 pp.
5. Satyanarayana, U., 1999. Biochemistry, Books and Allied (p) Ltd, New Delhi, 695 pp.
6. Joachim W. Hertramft and Felicitas Piedad – Pascal, 2000. Hand Book on Ingredients for Aquaculture Feeds. Kluwer Academic Publishers, London.
7. Robert R. Stickney, 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York, 1063 pp.
8. Jain, J.L., 2001. Fundamentals of Biochemistry. S. Chand and Co. Publishers. New Delhi, 924 pp.
9. Denniston, K.J., J.J. Topping and R.L. Caret, 2004. "General, organic and Biochemistry, 880 pp, McGraw hill publishing, New York, 880pp.
10. Nelson, D.L. and M.M. Cox, 2005. Lehninger Principles of Biochemistry, 1119 pp, W.H.Freeman and Company, 1119pp.

Course Outcomes

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

CO1:	Understand various aspects of aquaculture nutrition.
CO2:	Know the various the types of feed ingredients used in feed formulation besides various steps involved in it.
CO3:	Understand different types of feed used and its storage in aquaculture.
CO4:	Have thorough understanding on the types of live feed and their mass scale production in aquaculture
CO5:	Understand biochemical make-up of feeds used in aquaculture

Outcome Mapping

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

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

SEMESTER I
19CAQC 103 – PHYSIOLOGY, CYTOLOGY AND GENETICS

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To learn the physiology of fish respiration and digestion.
LO2: To know the osmoregulation and hormones in reproduction in fin and shellfishes.
LO3: To understand the physiological rhythms in marine animals.
LO4: To understand the different types of cells and tissues and also to learn the methodology adopted in chromosome preparation.
LO5: To gather knowledge on the genetics aspects involved in aquaculture.

UNIT 1: Physiology - General

Introduction to physiology, physiology of respiration – respiratory organs, mechanism of ventilation, respiratory pigments and gaseous exchange mechanism, physiology of igestion – enzymes and their role in food conversion processes.

UNIT 2: Osmoregulation

Ionic regulation – mechanism of excretion – ammoniotelic, uricotelic and ureotelic in organisms of coastal biotopes, hormones of19reproduction in fin and shellfish.

UNIT 3: Biorhythms

Physiological rhythms in marine animals – circadian, tidal and lunar rhythms, reproductive and behavioural rhythms, physiological changes during rhythms.

UNIT 4: Cytology

Types of cells and tissues – cytoplasmic inclusion at ultrastructural level, nucleus and nuclear components, nuclear envelope, cell divisions, chromosome preparation - methodology.

UNIT 5: Genetics

Principles of genetics, interactions and environmental influences, practical application of genetics – hybridization of fishes, recent trends and techniques in hybridization, selective breeding, cross breeding, development of disease resistance and high quality of new strains, transgenic fish production.

Chromosome manipulation, its role in aquaculture, androgenesis, gynogenesis, sex reversal and tripoidy, cryopreservation and conservation of germplasm. Transgenic fish.

Practical

1. Estimation on oxygen consumption and rate of respiration in a fish or a crab
2. Effect of hydrogen – ion concentration on amylase activity of the crystalline style
3. Effect of temperature and salinity on respiration of a fish or a crab
4. Effect of temperature – the rate of particle transport in a bivalve
5. The rate of particle filteration in bivalves
6. Hormone study – display of endocrine organs in a crustacea
7. Blood cell counts and haemoglobin estimation
8. Types of cells – study from slides
9. Mitosis – Meiosis – giant chromosomes
10. Preparation of chromosome in fishes
11. Induction of ploidy

REFERENCE BOOKS

1. Kirpichnikov, V.S., 1979. Genetic Bases of Selection in Fish. Springer – Verlag, Berlin, 410 pp.
2. Dass, P. and A.G. Jhingran, 1989. Fish Genetics in India. Today and Tomorrow Printers and Publishers, New Delhi, 266 pp.
3. Nagabhushanam, R., 1989. Text Books of Animal Physiology. Oxford IBH Publishing Co. Pvt. Ltd, New Delhi, 634 pp.
4. Trygve Gjedrem, 1990. Genetics in Aquaculture III (Journal of Aquaculture, Vol. 85). Elsevier Inc, New York, 340 pp.
5. De Robertis, E.D.P. and E.M.F. De Robertis, 1996. Cell and Molecular Biology. Waverly Pvt. Ltd., New Delhi, 734 pp.
6. Old, R.W. and S.B. Primrose, 1998. Principles of Gene Manipulation- an Introduction to Genetic Engineering. Blackwell Science Inc, New York, 474 pp.
7. Karp, Gerald, 2005. Cell and molecular biology: Concepts and Experiments John – Wiley and Sons, New York, 780pp.
8. Pandian, T.J., 2011. Sex determination in Fish, Saenll publishers / CRC Press. New York.

Course Outcomes

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

CO1:	Have an understanding on the physiology of fish respiration and digestion.
CO2:	Have knowledge on the osmoregulation and hormones of reproduction in fin and shellfishes.
CO3:	Understand the physiological rhythms involved in marine animals.
CO4:	Know various types of cells and tissues besides the methodology adopted for chromosome preparation.
CO5:	To understand various aspects and application of genetics in aquaculture.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**3**		**3**	**3**		**3**		**3**				
CO2	**3**		**3**			**3**		**3**				
CO3	**3**		**3**			**3**		**3**			**3**	
CO4	**3**		**3**	**3**		**3**		**3**			**3**	
CO5	**3**		**3**	**3**		**3**		**3**			**3**	

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

SEMESTER I

19CAQC 104 – AQUACULTURE ENGINEERING

Credits – 3
Hours: 3

Learning Objective (LO):

LO1: To learn the criteria involved in selection of site for brackish water farming.
LO2: To know the general principles and procedures of elementary engineering survey, planning of survey in coastal region for shrimp farming
LO3: To understand the components of a brackishwater shrimp farm.
LO4: To have knowledge on the different types of pumps and aerators.
LO5: To gather knowledge on the site selection, farm designing, construction of different types of open-sea farming practices.

Unit I

Principles of fish farm engineering – site selection – technical considerations – topography soil type, water supply, quality and dynamics.

Non-technical considerations – socio-economic, political and legal aspects.

Unit II

General principles and procedures of elementary engineering survey, planning of survey in coastal region, computation of area.

Unit III

Requirements of a brackishwater farm. Pond – its types, size, shape, design; Dyke – types, size and shape; Inlet and Outlet structures – types and design; supply and drainage canals – design and construction, operation and maintenance of farms.

Unit IV

Water supply to fish farm – controlling devices of flow, pump types – aerating equipments and filtration systems.

Unit V

Open sea – farming – site selection, Constraints and prospects of open sea farming – Culture in Cages, Pens, rafts rack and raceways: design, construction, repairing and maintenance. This paper is focussed mainly on the site selection farm designing, construction and different types of farming practices.

Practical

1. Survey of sites and topography studies
2. Study of soil characteristics in selected sites – Physical properties of soil – Texture – Permeability – Resistance – Chemical properties of soil – pH – Organic carbon – N.P.K. – Hydrogen sulphide
3. Survey of Water potentials and water quality characteristics
4. Measurement of velocity and discharge of tidal channel
5. Field visit to study the components of a brackishwater farm system
6. Drawing of layout of the farm visited
7. Observations / operation of pumps, aerators, feeding trays, etc

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 and Husbandry 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, 236 pp.
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:	Know criteria for selection of site for brackish water farming.
CO2:	Comprehend the general principles and procedures of elementary engineering survey, planning of survey in coastal region for shrimp farming
CO3:	Know various components of a brackishwater farm.
CO4:	Have thorough understanding on the various types of pumps and aerators.
CO5:	Know various steps involved in site selection, farm designing, construction of different types of open-sea farming practices.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3		3	3		3				3	3	
CO 2	3	3	3			3				3	3	
CO 3	3	3	3		3	3				3	3	
CO 4	3		3	3	3	3				3	3	
CO 5	3		3	3	3	3				3	3	

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

SEMESTER I
19CAQC 105 – AQUARIUM KEEPING AND MANAGEMENT

Credits – 3
Hours: 3

Learning Objective (LO):

LO1: To ascertain the global status, criteria for selection and common ornamental fishes.
LO2: To learn about the fabrication and designing of aquarium tank.
LO3: To understand the Aeration and filtration systems involved in aquarium maintenance.
LO4: To learn about the Setting up a tropical marine aquarium.
LO5: To gather knowledge about the basic health management practices in ornamental fish keeping.

Unit I - Introduction

Freshwater and marine aquaria – global status of aquarium fish keeping – advantages and benefits of fish keeping – criteria of choosing aquarium fishes – common aquarium fishes – collection techniques.

Unit II - Indoor aquarium

Tank designs – fabrication of tanks – choosing the right tank – buying and locating a tank.

Unit III Aeration and filtration

Air pumps – air operated filters – biofilters – Heating devices – aquarium thermostats – water quality maintenance – lighting methods.

Unit IV - Setting up an aquarium

Tropical marine set up – aquascaping – base covering – adding decorative materials – plants.

Unit V – Health Management

Basic diets – diseases and health management – treatment to sick fishes – guidelines for exhibiting fishes – photographing aquarium fishes.

Practical

1. Identification of common marine and freshwater aquarium fishes
2. Identification of common ornamental aquatic plant species.
3. Fabrication technique of glass aquarium tank
4. Operation of aquarium equipment and accessories
5. Conditioning and packing live aquarium species
6. Culture of live feed organisms
7. Breeding of live bearers
8. Breeding of egg layers
9. Identification and treatment of common ornamental fish diseases
10. Demonstration of Setting up of hi-tech aquarium tank
11. Field visits to commercial ornamental fish breeding farms

REFERENCE BOOKS

1. John Dawes, 1995. Live bearing Fishes (A guide to their Aquarium care, Biology and Classification) Cassell Pvt., London, 240 pp.
2. Lieske, E, Myers, R. 1996. Coral Reef Fishes, Princeton University Press, Prenceton, New Jersey, 400 pp.
3. Nick Dakin, 1996. The Interpet questions & Answers Manual of the Marine Aquarium. Interpet publishing, 206 pp.
4. Walter H. Adey and Karen Loveland, 1998. Dynamic Aquaria Building Living Ecosystems. Academic Press,New Delhi, 498 pp.
5. Sebastian J. Kuravamveli, 2002. The Aquarium Handbook. Amity Aquatech Pvt. Ltd., Cochin – 28.
6. Sundararaj, V. and J.M. Sathish, 2005. Tropical Marine Aquarium. Yegam Publications, Chennai, 144 pp.
7. Greg Jennings, 2006. 500 Freshwater aquarium fish: a visual reference to the most popular species hardcover, Firefly Books, Limited, 528 Pages.
8. Matthew L. Wittenrich, 2007. The Complete Illustrated Breeder's Guide to Marine Aquarium Fishes - Microcosm/TFH(ca), 304 Pages.
9. Vincent Hargreaves, 2007. Complete Book of the Freshwater Aquarium: A Comprehensive Reference Guide to More Than 600 Freshwater Fish And Plants, Plus How to Set Up And Maintain an Aquarium, Thunder Bay Press, 304 Pages.
10. Julian Sprung, et al., 2009. Marine Aquarium Handbook: Beginner to Breeder (3rd Edition), Microcosm, 351 Pages.

Course Outcomes

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

CO1:	Know the world status and criteria for selection of ornamental fishes.
CO2:	Have thorough knowledge on the fabrication and designing of aquarium tank.
CO3:	Understand the Aeration and filtration systems involved in aquarium maintenance.
CO4:	Knowledge on the Setting up a tropical marine aquarium.
CO5:	Thorough understanding on the basic health managements of ornamental fishes.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	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
CO5	3	3	3	3	3	3	3				3	3

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

Semester-I

19CAQP 107 - PRACTICAL I (COVERING COURSES CAQC 101, 104 & 105)

Credits: 3
Hours: 6

Semester-I

19CAQP 108 - PRACTICAL - II (COVERING COURSES CAQC 102 & 103)

Credits: 2
Hours: 4

II SEMESTER

19CAQC 201 – BIOLOGY AND CULTURE OF CRUSTACEANS

Credits – 3
Hours: 3

Learning Objective (LO):

LO1: To learn the historical background, present status, candidate species, culture importance, production of crustacean aquaculture.
LO2: To study the different stages of molting and its importance and to gather knowledge on various aspects in shell fish hatchery management.
LO3: To understand various types of culture practices: traditional, extensive, semi-intensive and intensive management practices of *Penaues monodon, P.indicus* and*Litopenaeus vannamei*.
LO4: To learn the culture and seed production techniques of giant freshwater prawn, lobsters and crabs.
LO5: To understand the production and economics of penaeid and non-penaeid shrimps in extensive and semi-intensive system

UNIT 1

An overview of Crustacean culture – historical background, general review and present status of culture of shrimps, lobsters and crabs and freshwater prawns in India and abroad. Important areas of culture, species of crustaceans cultured in different regions of the world and India, production and its trend.

UNIT II

Moulting – different stages of moulting, its influence on growth, interaction with reproduction and endocrine control of moulting.

Collection of brood stock and transportation, breeding under controlled conditions, brood stock development and management techniques of induced breeding. Hatchery production of seed, types of hatcheries, components of a hatchery - Nursery management and Feeding schedule.

UNIT III

Field culture – traditional culture practices prevailing in India and in other countries, advantages and disadvantages of these practices. Culture of *Penaues monodon, P.indicus* and *P.vannamei.*

Extensive, semi – intensive and intensive cultures - their management practices.

Unit IV

Culture of freshwater prawn *Macrobrachium* spp. and its seed production

Culture of lobsters and crabs in India and elsewhere – prospects and constraints.

Unit V

Production and economics - Shrimps and *Macrobrachium* culture in extensive and semi – intensive systems.

Practical

1. Collection and identification of prawns, shrimps, lobster and crab seeds from nature by using different nets.
2. Identification of larval forms of shrimp, prawn and crab from plankton collection
3. Technique of induced breeding and rearing of eggs through larval and post larval stages to stocking size, counting methods of eggs and nauplii in a hatchery.
4. Study of hatchery facilities like tanks, pumps, aerators, filters etc. in prawn hatcheries.
5. Determination of stocking density, techniques of field culture operation and monitoring of the stocked prawn through demonstration and field visits.
6. Recording and maintenance of data in a prawn and shrimp farms.
7. Field visit to observe harvesting operation, recording of data of production estimation.
8. Visit to sea food processing unit.
9. Visit to CIBA to see sea bass culture technology and feed mill etc.
10. Identification of males and females in commercially important fishes.
11. Hypophysation technique.

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 and Husbandry 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. Shigueno, K., 1978. Problems in Prawn Culture. Amerind Publishin Co. Pvt. Ltd., New Delhi, 103 pp.
6. Josianne., G Stottrup and Lesley A. McEroy, 2003. Live feeds in Marine aquaculture. Black well publishing, 313 pp.
7. David, A. Bengtson, 2003. Status of Marine aquaculture in relation to live prey: past, present and future, Black well publishing , 1-13.
8. Arnaud Muller, Feuga, Jeanne Moal and Raymond Kaas, 2003. The Microalgae of Aquaculture, 206 – 243.
9. Eva.E.Plaganyi, 2007. Models for an Ecosystem approach to fisheries. Organization of the United Nations, 108pp.

Course Outcomes

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

CO1:	Get an overview of Crustacean Aquaculture.
CO2:	Knowledge on the moulting and various aspects involved in shell fish hatchery management.
CO3:	Knowledge on various culture practices: traditional, extensive, semi-intensive and intensive management practices of *Penaues monodon, P. indicus* and *Litopenaeus vannamei.*
CO4:	Understanding on the culture and method of seed production of giant freshwater prawn, lobsters and crabs.
CO5:	Better understanding on the production and economics of penaeid and non-penaeid shrimps in extensive and semi-intensive systems

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**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**		**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**					**3**	**3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3			3	
CO2	3		3	3		3	
CO3	3			3		3	3
CO4	3			3		3	3
CO5	3					3	3
Total	**15**		**6**	**9**		**15**	**9**

SEMESTER II

19CAQC 202 – BIOLOGY AND CULTURE OF FINFISHES

Credits – 3

Hours: 3

Learning Objective (LO):

LO1: To learn the life history, food and feeding, age and growth and reproduction of cultivable finfishes.

LO2: To understand the distribution, resource assessment, collection and transportation of finfish seed.

LO3: To know various aspects of hatchery management practices

LO4: To understand various aspects in finfish culture practices

LO5: To learn polyculture and also to understand various steps involved in ornamental fish culture.

UNIT I: Finfish biology

Biology of cultivable finfishes - Life history – food and feeding – age & growth – reproduction

UNIT II: Seed

Seed production - distribution and abundance, methods for resource assessment and collection of seeds. packing and transportation.

UNIT III: Hatchery

Types of fish hatcheries – Fish hatchery components.

Artificial production of seed, breeding under controlled conditions, techniques induced breeding, egg incubation and larval rearing procedures and systems. Hatchery production of seeds, packing and transport of brooders and seeds.

UNIT IV: Fin fish Culture

Culture practices in ponds of important finfish species, preparation and management of nursery and grow – out ponds, eradication of undesirable organisms, nursery technique, pond fertilization, stocking, feeding and provision for removal of metabolites.

UNIT V: Polyculture

Polyculture – species selection for polyculture, criteria and characteristics of species selected for polyculture, stocking density and ration, feeding and management.

Ornamental fish culture

Ornamental fish culture. Production and economics – optimal size for harvesting, methods of harvesting economics.

Practical

1. Identification of fish eggs and larvae from plankton collection
2. Collection and identification of seeds from wild using different gears and seed resource survey.
3. Identification of important cultivable species and common ornamental fishes.

4. Techniques of induced breeding – dissection, preservation and demonstration of pituitary gland in alcohol and glycerol, rearing of eggs and larvae.
5. Observation on the management practices of nursery and stocking ponds, stocing density.
6. Field visit to finfish culture systems and submission of report
7. Harvest, data recording, growth and production estimation.
8. Methods of transport of seeds and brooders.

REFERENCE BOOKS

1. 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.
2. Pilly, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books) ltd., London, 497 pp.
3. Hornell, J., 1984. Marine Fish Farming for India. Shanthi Books, Madras, India, International Books and Periodicals Supply, 83 pp.
4. Shanmugam, K., 1990. Fishery Biology and Aquaculture. Leo Pathippagam, Madras, India, 342 pp.
5. Santhanam, R., N. Ramanathan and G. Jegadeesan, 1990. Coastal Aquaculture in India, CBS Publication, Delhi – 32, 180 pp.
6. Khanna, S.S. and H.R. Singh, 2003. A textbook of fish biology and fisheries. Narendra Publishing House, New Delhi, 524pp.
7. Gurdarshansingh and H. Bhaskar, 2003. An introduction to fishes. Campus Books International, New Delhi, 436pp.
8. Nick Dakin, 2004. The Marine Aquarium. Oxford Publishing, London, 206 pp.
9. Sundararaj, V. and J.M.Satheesh, 2005. Trophical Marine Aquarium, Yegam Publications, Chennai, 140 pp.

Course Outcomes

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

CO1:	Getting an overview of biology of finfishes
CO2:	Knowledge on the resources, collection and transportation finfish seed.
CO3:	Understanding on the techniques and management practices in finfish hatchery
CO4:	Have thorough knowledge on the various aspects of fin fish culture.
CO5:	Gather knowledge on the polyculture and ornamental fish culture

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**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**		**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**					**3**	**3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3			3	
CO2	3		3	3		3	
CO3	3			3		3	3
CO4	3			3		3	3
CO5	3					3	3
Total	**15**		**6**	**9**		**15**	**9**

SEMESTER II

19CAQC 203 – BIOLOGY AND CULTURE OF MOLLUSCS AND SEAWEEDS

Credits – 3
Hours: 3

Learning Objective (LO):

LO1: To learn life history, food and feeding, age and growth and reproduction of cultivable molluscs.
LO2: To understand the distribution, resource assessment, collection and transportation of molluscan seed (spat).
LO3: To ascertain various types and aspects involved inmolluscan hatchery management
LO4: To understand various steps involved in molluscan aquaculture.
LO5: To learn the seaweed culture practices.

UNIT1: Biology - molluscs

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

UNIT 2: Seed from Nature

Natural seed resources, utilization, 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: Hatchery

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: 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: Seaweeds

General introduction to seaweeds – criteria for selection of candidate species in India, biology – life history, growth, reproduction of *Ulva*, *Laminaria* and *Gracilaria.*

Culture :

Seaweed culture – technology for higher yields, products from seaweeds (agar, algin and carageenan) and extraction methods, production and ecomomics of seaweed culture, economic importance of seaweeds.

Practical

1. Collection of molluscan seed – materials, preparation and laying of spat collectors, observation of spat fall.
2. Farm visit to witness seeding, growth, measurement, thinning, harvesting and *in situ* measurements of production.
3. Induction of spawning by physical, chemical and biological techniques.
4. Identification of locally available seaweeds.
5. Demonstration of algin and agar extraction.
6. Field visit to observe the culture of seaweeds and the technique of harvest.
7. Submission of field report.
8. Identification of males and females in commercially important hypophy technique

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:	Understand the overview of molluscan biology.
CO2:	Know the resources, collection and transportation molluscan seed.
CO3:	Thorough understanding on the molluscan hatchery and its types.
CO4:	Understanding on various aspects of molluscan aquaculture.
CO5:	Knowledge about seaweed culture and its importance.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**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**		**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**					**3**	**3**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3			3	
CO2	3		3	3		3	
CO3	3			3		3	3
CO4	3			3		3	3
CO5	3					3	3
Total	**15**		**6**	**9**		**15**	**9**

SEMESTER II

19CAQC 204 – HEALTH MANAGEMENT IN AQUACULTURE SYSTEMS

Credits – 3
Hours: 3

Learning Objective (LO):

LO1: To know about importance of marine microbiology and pathologyin aquaculture system.
LO2: To learn methods of isolation and culture of microorganisms. To glean knowledge on the microbial nutrition and influence of environmental factors on microbial growth and activity, structure and biology of bacteria and viruses
LO3: To understand the incidence of various diseases of fin and shell fishes
LO4: To know the adoption of modern techniques employed in disease diagnostics
LO5: To learn the preventive measures/quarantine procedures adopted against diseases.

UNIT 1: Microbiology

General introduction to marine microbiology and pathology – their importance in aquaculture system – Health management in aquaculture system**.**

UNIT 2: Methods: Isolation and Culture

Methods of studying the coastal microorganisms – methods of collection of water, sediment, finfish and shellfish samples, isolation and culture of bacteria, enumeration, total and viable counts, identification of bacteria based on their morphological, physiological and biochemical characteristics.

Microbial nutrition, influence of environmental factors on microbial growth and activity, structure and biology of bacteria and viruses.

Role of microorganisms in the cycling of minerals – sulphur cycle, nitrogen cycle and phosphorus cycle, probiotics.

UNIT 3: Diseases – Finfishes

Disease development factors involved, abiotic and biotic.

Detailed study on diseases of finfish (food fishes) – viral, bacterial, fungal, parasitic (protozoan & metazoan), environmental and nutritional diseases.

Diseases of ornamental fishes.

UNIT 4: Diseases – Shell fishes

Detailed study on shellfish diseases (shrimp, lobster, molluscs) – viral, bacterial, fungal, parasitic (protozoan & metazoan), environmental and nutritional diseases.

Larval health monitoring with special reference to shrimps and fishes.

Modern techniques employed in diagnosis of diseases in cultivable organisms with special reference to shrimps, WSSV sample collection and preparation for different techniques (microbiology, immune studies)

UNIT 5: Diseases – Prevention

Prevention of diseases – Good management procedure (GMP) - environmental and physical methods, chemical methods, biological methods.

Salinity practices and prophylactic measures – in hatcheries and grow out ponds, disinfection procedures, water quality standards and their levels associated with fish

health and disease, common chemicals and antibiotics in use, toxic substances damaging fish health.

Immune mechanisms and immunization of cultivable organisms.

Practical

1. Preparation of Media
2. Microbial population enumeration in water and sediment of ponds and fin and shellfish samples.
   Pond water samples
   Pond sediment samples
3. Isolation of pathogens from diseased specimens
4. Separation of mixed cultures, different types of streaking – phase streaking, continuous streaking, 'T' streaking and radial streaking.
5. Estimation of Coliforms – MPN method.
6. Identification of bacteria, staining – negative, simple and gram, motility test – Hanging drop method (or) using Semisolid medium,
   Biochemical tests – oxidase, catalase, triple sugar iron agar, decarboxylase, arginine, lysine, ornithine, indole, oxidation fermentation test, nitrate reduction test, methyl red test, voges test, proskauer test, citrate test, starch hydrolysis, gelatin hydrolysis, casein hydrolysis.
7. Antibiotic assay
8. Isolation of fungi from old stocked feeds
9. Identification of fungi
10. Larval Health monitoring – shrimp
    Microbial load – bacteria, fungi, protozoa.
    Physiological / physical manifestations
    Occlusion bodies
11. Demonstration of disease symptoms through histopathological slides
12. Demonstration of dot plot and PCR

REFERENCE BOOKS

1. Conroy, D.A. and R.L.Herman, 1997. Text Book of fish diseases, Narendra Publishing House, New Delhi, 301 pp.
2. Woo, P.T.K. and D.W. Bruno, 1998. Fish Diseases and Disorders – Vol. 3. Viral, Bacterial and Fungal Infections. CABI Publishing, New Delhi 874 pp.
3. Presscott, L.M., Harley, J.P. and D.A. Klein, 1999. Microbiology, McGraw Hill Inc, NewYork pp. 962.
4. Wedemeyer, G.A., Meyer, F.P. and L. Smith, 1999. Environmental Stress and fish diseases, NPH Publishing House, New Delhi192 pp.
5. Austin B. and D.A. Austin, 1999. Bacterial Fish Pathogens – Diseases of farmed and wildfish. Springer Praxis Publishing, NewYork, 457 pp.
6. Stickney, P.R., 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc, NewYork, 1063 pp.
7. Cann, A.J., 2000. DNA virus replication. Oxford University Press, London, 232pp.
8. Dimmock, N.J., A.J. Easton and K.N. Jeppard, 2001. "Introduction to Modern Virology Blackwell Science, NewYork, 449pp.
9. John Humphrey, J. Richard Arthur, Rohana P. Subasinhe and Michael J.Philips, 2005. Aquatic animal quarantine and health centification in Asia. FAO, Daya publishing House,145pp.

10. Aquatic animal quarantine and health centrification in Asia. FAO, Daya publishing House,145pp.

Course Outcomes

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

CO1:	Getting an overview of importance of marine microbiology and health management in aquaculture system.
CO2:	Knowing methods of isolation, culture, microbial, nutrition, growth, activity, structure and biology of coastal bacteria and viruses
CO3:	Knowledge on the incidence of various diseases of fin and shell fishes
CO4:	Knowing the adoption of various modern techniques employed in disease diagnosis.
CO5:	Learning about various preventive measures of diseases

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**3**		**3**	**3**		**3**		**3**			**3**	
CO2	**3**	**3**	**3**			**3**		**3**			**3**	
CO3	**3**	**3**	**3**		**3**	**3**				**3**	**3**	
CO4	**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	
CO2	3		3			3	
CO3	3				3	3	
CO4	3				3	3	
CO5	3		3		3	3	
Total	**15**		**9**		**9**	**15**	

SEMESTER II

19CAQC 205– POST HARVEST TECHNOLOGY

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To learn about importance of preservation and processing of sea food and also to understand the basic concepts of HACCP.
LO2: To understand various types of fish spoilage and its causative factors
LO3: To know various types of drying and curing techniques used in fish processing with their merits and demerits.
LO4: To understand various types of freezing and canning techniques used in fish processing with their merits and demerits.
LO5: To understand various fishery by-products and their uses.

UNIT 1: Importance of preservation and processing

Cultured organisms, criteria for assessing the freshness of cultured organisms – handling of fresh materials, phenomena of rigor mortis, quality assurance, HACCP – Concepts – Plans – Hazard Analysis – Identification – Assessment.

UNIT 2: Fish spoilage

Types of fish spoilage, causative factors – autolytic spoilage, microbial spoilage, oxidative changes.

UNIT 3: Drying and Curing

Dehydration – conventional and modern methods of drying (Solar driers), relative merits and demerits.

Salt curing, pickling and smoking – merits and demerits.

UNIT 4: Freezing and canning

Cold storage – various types of freezers, individually quick freezing (IQF), cold storage design and equipments, freeze – drying, canning – history of canning containers, canning procedures.

UNIT 5: Fishery By-products

Fishery by – products of commerce – processing of miscellaneous products, fish meal, oil, fish protein concentrate, fish wafers, ensilage, chitosan etc., development of diversified products.

Antibiotic residue analysis – Muddy smell - marketing – export – domestic – economics.Marketing role of MPEDA.

Practical

1. Field visit to different processing plant and submission of report
2. Quality Analysis in Fishes
3. Proximate composition in fresh and ice stored
   Fishes
   Moisture
   Protein
   Ash
   Acid insoluble ash
   Fat
   Peroxide value
   Free fatty acid
   Thiobarbitoric acid value
4. Sensory analysis in Fishes and Prawns
5. Prawns – Formulation of different products for export
   PD
   PUD
   HL
   Fillets
6. Analysis of Indole in Prawns
7. Ice storage studies – observations – nature of the eyes, gills, texture, peritonium, fibrousness, smoothness, toughness succulence.
8. pH – Fresh & Stored Fishes and Prawns.
9. Shell fish poisoning in processed fish.
10. Microbial Analysis
    Total bacterial count
    Coliforms
    Staphylococcus
    Streptococci
11. Preparation of certain by – products and miscellaneous products.
12. Preparation of Coated Products.

REFERENCE BOOKS

1. Burges, G.H.O., C.L. Cutting, J.A. Lovern and J.J. Waterman, 1965. Fish Handling and Processing Her Majesty's Stationery Office, Edinburg, 390 pp.
2. Pillay, T.V.R., 1972. Coastal Aquaculture in the Indo – Pacific Region. Fishing News (Books), London.
3. Kreuzer, R., 1974. Fishery Products. FAO Fishing News (Books), England, 462 pp.
4. Govindan, T.K., 1985. Fish Processing Technology. Oxford and IBH publishing Company Private Ltd, 252 pp.
5. Gopakumar, K. 1997. Tropical Fishery Products. Oxford & IBH Publications, 190 pp.
6. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fish Products. Daya Publishing House, New Delhi, 440 pp.
7. Balachandran,K.K, 2001. Post harvest Technology of fish and fish products. Daya Publishing House, New Delhi, 440 pp.
8. Malhotra,S.P. V.R.P.Sinha, 2007. Indian fisheries and Aquaculture in a globalizing economy. Narendra Publishing House, New Delhi, 385 pp.

9. Dietrich Knorr, 2005. Food Biotechnology, Marcel Dekker Publishing, New York.
10. Vickie, A. Vaclavir, Elizabeth W. Christian, 2009. Essentials of food Science – Second edition Springer – Food Science text series, New York.

Course Outcomes

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

CO1:	Thorough understanding on various aspects of processing and preservation i.e., handing of fishes, rigor mortis, quality assurance, HACCP concepts etc.
CO2:	Knowledge on fish spoilage and its causative factors.
CO3:	Understanding on the summary of drying and curing methods along with their merits and demerits.
CO4:	Knowledge on freezing and canning methods along with their merits and demerits.
CO5:	Thorough comprehension on various fish by-products with their uses.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**3**	**3**	**3**	**3**		**3**				**3**		
CO2	**3**	**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**

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3				3		
CO2	3				3		
CO3	3						3
CO4	3					3	3
CO5	3					3	3
Total	**15**				**6**	**6**	**9**

Semester-II

19CAQP 206: PRACTICAL III (COVERING COURSE CAQC 201)

Credit: 1
Hours: 2

Semester-II

19CAQP 207: PRACTICAL IV (COVERING COURSES CAQC 202 & 203)

Credit: 3
Hours: 6

Semester-II

19CAQP 208: PRACTICAL - V (COVERING COURSES CAQC 204 & 205)

Credit: 3
Hours: 6

SEMESTER III

19CAQC 301 – INSTRUMENTAION AND ANALYTICAL METHODS

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To study the various methods/various field instruments used in aquaculture
LO2: To learn about the principles of the various microscopes and centrifugation
LO3: To study on the working principle of spectrophotometers
LO4: To have knowledge on the electrophoresis and chromatography
LO5: To get immense knowledge and skill in the preparation of whole mount

UNIT 1: Field Equipments

Minor equipments – Working principles and uses of water and sediment samplers – secchi disc, lux meter, turbidity meter, pH meter, oxygen analyzer, refractometer, salinometer, echosounder,.

UNIT 2: Microscopes and Centrifuge

Microscopy – light microscope, phase contrast, electron microscope, and photomicrography.

Centrifugation – Centrifugal force and principles of sedimentation, sedimentation co-efficient, types of centrifuges, types of centrifugation, molecular weight determination.

UNIT 3: Spectroscopy

Absorption and emission principles – Principles and application of colorimeters, UV visible spectrophotometers, spectroflurometer, Flame photometer, atomic absorption spectrophotometer, Inductively coupled plasma spectrometer (ICP).

UNIT 4: Electrophoresis and Chromatography

Electrophoresis: General principles – factors affecting mobility of charged molecules – principles and uses of electrophoresis, agarose gel electrophoresis, pulsed field gel electrophoresis, isoelectric focusing, polyacrylamide gel electrophoresis.

Chromatography: Paper, thin layer, gas chromatography high performance liquid chromatography, ion-exchange chromatography – principles and uses of each type.

UNIT 5 – Microtechnique

Microtechnique – sliding and rotary microtomes, freezing microtome, specimen fixation, dehydration, embedding and sectioning, staining of sections, whole mount preparation.

Practical

1. Study of light, phase contrast & electron microscopes
2. Photomicrography
3. Measurements using microscopes- ocular & stage micrometer
4. Preparation of whole mount
5. Paper Chromatography
6. Thin layer Chromatography
7. Electrophoresis

REFEERNCE BOOKS

1. Richard W. Von Norman, 1963. Experimental Biology. Prentice – Hall, New York.
2. Gunter Zweig and Joseph Sherma, 1972. Handbook of Chromatography Vols. I & II. Cleveland, Ohilo 44128. (317 pp)
3. Gabe Manfred, 1976. Histological Techniques. Springer – Verlag, New York.
4. Galan W. Ewing, 1985. Instrumental Methods of Chemical Analylsis.. McGraw – Hill Book Company, 538 pp.
5. Skoog, D.A. and J.J. Leary 1992. Principles of Instrument Analysis. Fourth Edition. Saunders College Publishers, Philadelphia, 700 pp.
6. Hawley, T.S. and R.G. Hawley, 2004. Flow cytometry protocols, Humana Press, 434 pp.
7. Gilian Mc Mohan, 2007. Analytical Instrumentation. A Guide to Laboratory, portable and miniaturized Instruments. John Wiley & Sons Ltd, England, 283 pp. ISBN 978 – 0470 – 027950.
8. Susanta Latiri, 2008. Trace analysis. Narendra Publishing House, New Delhi, 186 pp.
9. Rasan Katoch, 2011. Analytical Techniques in Biochemistry and molecular Biology, Springer Science & Business media, LLC, USA, c 431 pp, ISBN– 978-1– 4419– 9784-5

10. Springer Science & Business Media, LLC, USA, c 431 pp, ISBN – 978 – 1-4419-9784-5

Course Outcomes

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

CO1	Knowledge on the use of different field equipments in aquaculture
CO2	Thorough information on the microscopes and photomicrography along with different types of centrifuge, principle and their use in aquaculture
CO3	Understanding on the working principle and use of spectroscopy
CO4	Learning different types of electrophoresis and chromatography
CO5	Knowledge on the various types of microtome, whole mount preparation

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**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**	
CO5	**3**		**3**	**3**	**3**	**3**				**3**	**3**	

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

SEMESTER III

19CAQC 302 – BIOTECHNOLOGY AND APPLIED MARINE BIOLOGY

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To learn the application of genetics in aquaculture and genetic engineering in marine organisms
LO2: To know the application of different marine bioactive compounds, role of sea food in human health and mangrove forestry
LO3: To get knowledge on disease diagnosis concepts adopted in aquaculture
LO4: To learn cell and tissue culture techniques
LO5: To know mass culture of microbes and utility of different marine products along with the management of marine resources.

UNIT 1: Genetics

Application of genetics, coastal aquaculture - genetic engineering and biotechnology in marine organisms.

UNIT 2: Pharmacology

Application of biological concepts / systems in the seafood industries – seafood biochemistry - human health – marine pharmacology, bioactive compounds from marine flora and fauna and environment – mangrove coastal forestry.

UNIT 3: Immunology

Disease diagnosis – concepts, ELISA, dot immunobinding, western blotting, latex agglutination test, monoclonal antibodies – DNA based diagnosis of diseases, fish vaccines.

UNIT 4: Biotechnology

Rural and industrial biotechnologies – cell and tissue culture, microbial biofertilizers, microbial enzymes, fermentation, effluent treatments, biocorrosion, biofouling.

UNIT 5: Uses

Production of biological systems for commercial utility;

Mass scale culture of microbes, seaweed – agar agar – other products – utilization. Peoples participatory approach - marine resource - management.

Practical

1. Visit to biotechnology industries / Laboratories
2. ELISA test
3. Amplification of DNA
4. Gel electrophoresis
5. Cell and tissue culture
6. Chromosome studies

REFERENCE BOOKS

1. David H. Attaway and R. Oskar, 1993. Marine Biotechnology. Vol. I. Pharmaceutical & Bioactive Natural Products. Plenum Press, New York & London, 500 pp.

2. Dubey, R.C., 1993. A Text Book of Biotechnology. S. Chand & Com. Ltd., New Delhi, 702 pp.
3. Singh, B.D., 1998. Biotechnology. Kalyani Publishers, Ludiana, N.D., Noida U.P., 694 pp.
4. Glick, B.R. and J.J. Pasternak, 1998. Molecular Biotechnology: Principles and applications of recombinant DNA, ASM Press, NewYork, 683 pp.
5. Milton Fingerman, R. Nagabushanam and Mary – Frances Thompson, 1999. Recent Advances in Marine Biotechnology, Vol. 1,2,3.
6. Pat Vaughan, 2000. Methods in Molecular Biology: DNA Repair protocols: Prokaryotic Systems, 209pp.
7. Rodney, J.Y. Ho, Milogibaldi, 2003. Biotechnology and Biopharmaceuticals, Wiley Liss publication, New Jersy, 556 pp.
8. Bhatia, S.C. 2005. Text book of Biotechnology, Atlantic Publishers, New Delhi, 492 pp.
9. Bir Bahadur, 2005. Essentials of Biology and Biotechnology. Pharma Book Syndicate, 594 pp.
10. Ghose, T.K and P. Ghose, 2008. Biotechnology in India. Part – I Springer Publishing, India, 292 pp.

Course Outcomes

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

CO1	Learning gene manipulation techniques involved in the aquaculture practices
CO2	Understanding on the pharmacological role of different marine organisms
CO3	Knowledge on the various disease diagnosis concepts used in aquaculture
CO4	Learning cell and tissue culture techniques and other biological products of biotechnology
CO5	Gathering knowledge on different marine resources and their management

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**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**
CO5	**3**		**3**	**3**	**3**	**3**		**3**	**3**	**3**		**3**

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

SEMESTER III

19CAQC 303 – AQUACULTURE INFORMATION, ECONOMICS AND EXTENSION

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To know about various land leasing policies; maritime states and process involved in registration of land and other technical considerations.
LO2: To understand various roles of financial and insurance institutions and steps involved in getting financial support and insurance cover.
LO3: To gather knowledge on data collection and processing in different aquaculture practices.
LO4: To learn the use of internet and other media as a tool for collection of data in aquaculture and also to ascertain the role of WTO and IPR issues in aquaculture.
LO5: To understand the extension education, rural development, socio – economics, marketing, internal and external markets and trade, demand and supply.

UNIT 1: Registration

Land leasing polices of maritime states, setting – up of aquaculture farm in practice how to go about, purchase of land, registration, registration in MPEDA / BFDA for getting subsidy and technical guidance, getting electric connection and other practical considerations.

UNIT 2: Funds

Role of financial institutions – availing bank loan – formalities to be followed.

Role of insurance companies – formalities to be followed for getting insurance cover and preparation of claim for loss.

UNIT 3: Data

Data base collection and Data processing: Data collection in different aquaculture practices - Traditional, extensive, semi-intensive and intensive culture- Relative economic model for the different practices.

UNIT 4: Information

Aquaculture information – Internet, information collection of aquaculture practices – Dissemination processes – WTO, IPR issues in aquaculture farming.

UNIT 5: Extension

Fishery extension – principles of extension, theory of motivation, extension methods and evaluation. Extension education.

Status of extension activities, transfer of technology, behavioural pattern of fishermen to structural changes, adoption of villages for integrated rural development, socio – economics, marketing, internal and external markets and trade, demand and supply.

Practical

1. Visit of fishermen co-operative society.
2. Visit to aquaculture farms.
3. Income statement analysis.
4. Preparation of farm plans and budgets.
5. Preparation leaflets, folders, pamphlets, circular letter, poster, charts etc for fisheries extension activities.
6. Preparing and practicing a script for radio talk and public speaking.
7. Training to get license, Subsidy and from the Government.
8. Identification of fishes for Integrated farming.
9. Estimation of Ammonia, Hydrogen sulphide and organic matter
10. Identification of Zeolite and lime used in aquaculture.
11. Submission of field report.

REFERENCE BOOKS

1. Bardach, F.E., J.H. Ryther and W.O. Mc Larney, 1972. Aquaculture: Farming and Husbandry of Freshwater and Marine Organisms. Wiley Interscience, New York.
2. Brown, E., 1976. World Fish Farming: Cultivation and Economics.
3. James Hornell., 1984. Marine Fish farming for India, International Books & Periodicals Supply service, 81 pp.
4. MPEDA, 1995. Sea fishes, Special publications, 63 pp.
5. MPEDA, 1995, Shrimp Hatchery, 65 pp.
6. Barry A. Costa, Pierce, 2002. Ecological Aquaculture, The evolution of the blue revolution, Black Well Science, 382 pp.
7. Pillay.T.V.R. and M.V. Kutty, 2005. Aquaculture principles and practices, Fishing News (Books), London. 624pp.
8. Tucker, C.S and Hargreaves, J.A, 2008. Environmental best management practices for aquaculture, Wiley Blackwell, New York.
9. Handbook on aqua farming shrimp, lobster, mud crab-MPEDA-Kochi, 72pp.

Course Outcomes

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

CO1	Knowledge on land leasing policies for aquaculture and other technical consideration involved in setting up of a aquaculture farm
CO2	Learning about different financial and insurance agencies and steps involved in getting financial support and insurance coverage.
CO3	Knowledge on data collection and processing in different aquaculture practices.
CO4	Thorough knowledge on the use of internet and other media as a tool for collection of data in aquaculture.
CO5	Knowledge on extension education, rural development, socio – economics, marketing, internal and external markets and trade, demand and supply.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**3**		**3**	**3**		**3**						
CO2	**3**		**3**			**3**						
CO3	**3**		**3**		**3**	**3**						**3**
CO4	**3**		**3**	**3**	**3**	**3**						**3**
CO5	**3**		**3**	**3**		**3**						**3**

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

SEMESTER III

19CAQC 304 -BIOENTREPRENEURSHIP

Credits – 4
Hours: 4

Learning Objective (LO):

LO1: To learn various aspects of accounting/ finance in building an entrepreneurship.
LO2: To gain insights on marketing strategies in Aquaculture
LO3: To know usage of information technology in developing an entrepreneurship
LO4: To learn about various aspects of Human Resource Development i.e., leadership, motivation, teamwork, appraisal etc.
LO5: To gather information on primary aspects of entrepreneurship and role of different knowledge centre and R & D institute for technology transfer.

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; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

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

With financiers, bankers etc.; With government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking

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 upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

Practical
Case Study

1. Candidates should be made to start a 'mock paper company', systematically following all the procedures.
- The market analysis developed by them will be used to choose the product or services.
- A product or service is created in paper and positioned in the market. As a product or services available only in paper to be sold in the market through the existing links. At this juncture, the pricing of the product or the service needs to be finalized, linking the distribution system until the product or services reaches the end consumer.
- Candidates who have developed such product or service could present the same as a project work to the Panel of Experts, including representatives from industry sector. If the presented product or service is found to have real potential, the candidates would be exposed to the next level of actual implementation of the project.

2. Go to any venture capital website (like sequoiacap.com) and prepare a proposal for funding from venture capital.

REFERENCE BOOKS

1. Hine, D. and J. Kapeleris, 2006. Innovation & Entrepreneurship in Biotechnology, An International Perspective- Concepts, Theories and Cases, Edward Elgar Publishing Limited, UK 259pp.
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	Understanding on the role of finance and accounting in an entrepreneurship.
CO2	Knowledge on various aspects of marketing.
CO3	Knowing the usefulness of information technology in an enterprise and other recent techniques of e-business.
CO4	Learning leadership, managerial skills and other concepts related to human resource development.
CO5	Gathering knowledge on fundamental of entrepreneurship and role of knowledge centres and R&D institutes in technology transfer.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	**3**	**3**	**3**	**3**		**3**						
CO2	**3**	**3**	**3**			**3**						
CO3	**3**		**3**		**3**	**3**						
CO4	**3**		**3**	**3**	**3**	**3**						
CO5	**3**		**3**	**3**	**3**	**3**						

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

Semester-III

19CAQP 307: PRACTICAL VI (COVERING COURSES CAQC 301& 303)

Credit: 3
Hours: 6

Semester-III

19**CAQP 307 PRACTICAL VII : (COVERING COURSE CAQC 302)**

Credit: 1
Hours: 2

SEMESTER IV

19CAQC 401: PLANT AND ANIMAL CELL CULTURE TECHNOLOGY

Credit: 4
Hours: 4

Learning Objective (LO):

LO1: To learn structure and organization of animal cell, cell proliferation, cell differentiation, cell adhesion, senescence and cell transformation.
LO2: To get knowledge on cell culture media, cell lines and cell separation.
LO3: To know about adherent & non adherent cell lines, culture methods, subculture, cryopreservation, contamination of animal cells.
LO4: To get an overview on plant tissue culture.

LO5: To gather knowledge on the explant, surface sterilization, plant growth hormones, micro propagation, somatic hybridization, plant transformation and applications of plant tissue culture.

Unit I

Structure and organization of animal cell - Cell proliferation – Cell differentiation – Cell adhesion – Senescence – Cell transformation

Unit II

Cell culture media: Components, physicochemical properties – Serum: Components, advantages and disadvantages, serum free media – Use of Antibiotics – Primary cell culture: Initiation of cell culture, mechanical and enzymatic disaggregation – Cell lines: Development, characterization, maintenance – Cell separation

Unit III

Adherent & non adherent cell lines – Culture methods – Subculture – Cryopreservation – Contamination in animal cell culture – Quantification and cytotoxicity – Embryonic stem cells – cancer stem cells.

Unit IV

Plant tissue culture – Introduction, cellular totipotency, basic requirements for plant tissue culture laboratory, tissue culture media (constituents and preparations), types of culture – cell, protoplast, callus, suspension culture and its applications.

Unit V

Explant, surface sterilization, plant growth hormones, micropropagation (direct and indirect method), somatic hybridization, plant transformation technique using *Agrobacterium tumefaciens*, applications of plant tissue culture.

REFERENCE BOOKS

1. Razdan, M. K., 2003. Introduction to plant tissue culture (2nd Edition), Science Publishers, USA. 375 pp.
2. Martin Clynes, 1998. Animal Cell Culture Techniques. Ed. Springer, NY, 618 pp.
3. Rudolf Endreb, 2004. Plant cell biotechnology –Springer publications, NY, 368 pp.
4. Robert N. Trigiano and Dennis J. Gray, 2004. Plant tissue culture concepts and laboratory exercises (2nd Edition), CRC, USA, 454 pp.
5. Gerald Karp, 2008. Cell and Molecular Biology, Wiley Press, USA, 843 pp.

Course Outcomes

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

CO1	Learning structure and organization of animal cell, cell proliferation, cell differentiation, cell adhesion, senescence and cell transformation.
CO2	Thorough knowledge on cell culture media, cell lines and cell separation
CO3	Knowledge on an overview of animal cell culture.
CO4	Learn about plant tissue culture.

CO5	Gathering knowledge about explant, surface sterilization, plant growth hormones, micro propagation, somatic hybridization, plant transformation and applications of plant tissue culture.

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
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**		

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

19CAQP 404 - Project work

Semester-IV **Credits: 8**

Department Electives (DE)

19 CAQE 305 Disaster Management

Credits: 3

Hours: 3

Learning Objective (LO):

LO1**:** To study the coastal hazards, risk assessment and disaster management strategies in India.

LO2: To study the types of hazards in fisheries sector and other impact of natural disasters

and assessment.

LO3: To study the disaster management strategies during the pre-disaster and post disaster periods.

LO4: To study the response and recovery systems at national, state and local, coordination between different agencies.

LO5: To study the Prevalent national and global management practices in disaster managements.

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.

REFERENCE BOOKS

1. Harsh K. Gupta ,2003. Disater Managemnet, University press, 152pp.
2. Damon P. Coppola, 2015. Introduction to International Disaster Management, Butterworth-Heinemann, 760pp.
3. I.Sundar T.Sezhiyan,2007. Disaster Management, Sarup & Sons, 182pp.
4. Jack Pinkowski, 2008. Disaster Management Handbook, CRC Press, 624pp.
5. Rajiv Sinha, Rasik Ravindra, 2012. Earth System Processes and Disaster Management, Springer Science & Business Media, 244pp.

Course Outcomes

At the end of the course, the student will be able 54to

CO1:	To understand coastal hazards, risk assessment and disaster management strategies in India
CO2:	To understand the types of hazards in fisheries sector and other impact of natural disasters and assessment.
CO3:	To understand the disaster management strategies during the pre-disaster and post disaster periods.
CO4:	To understand the response and recovery systems at national, state and local, coordination between different agencies
CO5:	To understand the Prevalent national and global management practices in disaster managements.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3		3	3		3	3	3		3	3	
CO 2	3		3			3	3	3		3	3	
CO 3	3		3		3	3	3		3	3	3	3
CO 4	3	3	3	3	3	3	3		3	3	3	3
CO 5	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
Total	15	12	09	09	15	15	09

19CAQE306 Marine Food Technology

Credits: 3
Hours: 3

Learning Objetives (LO):

LO1: To study the preservation and processing methods and type of preservatives in fish processing.
LO2: To study the packing methods, utilization and preparation of fishery by-products.
LO3: To study the spoilage of seafood caused by mircroorganisms and their controll measures.
LO4: To study the qulality management of fishery products and certification approaches for commerical applications.
LO5: To study the product development and nutrition promotion, consumer studies qualitative and quantitative research methods.

Unit I

Preservation and processing – chilling methods, phenomena of rigor mortis, spoilage changes – causative factors. Drying – conventional methods. Salt curing, pickling and smoking. Freezing and cold storage, Canning procedures. Role of preservatives in processing.

Unit II

Packing – handling fresh fish, frozen packs, IQF, layered and shatter packs. Fishery by – products, cannery waste, feeds, silage, fish gelatin, fish glue, chitin and chitosan, pearl essence, fertilizer.

Unit III

Seafood microbiology – factors influencing microbial growth and activity. Seafood borne pathogens – bacteria, fungi, viruses. Spoilage factors in seafood. Toxins influencing food spoilage. Microbes as food – SCP, microbial neutraceuticals.

Unit IV

Quality management – concepts, planning, system, quality control, quality assurance, quality improvement. Certification standards – ISO and HACCP. Principles of quality related to food sanitation, contamination, pest control, human resource and occupational hazards.

Unit V

Novel product development, marketing and sea food export – MPEDA, marketing, government policies, export finance, economic importance. Novel products – nutrition promotion, consumer studies qualitative and quantitative research methods

REFERENCE BOOKS

1. Kreuzer, R., 1974. Fishery Products, FAO Fishing News (Books) Ltd., England, 280 pp.
2. Anon, 1979. Handling, Processing and Marketing of Tropical Fish. Tropical Products Institute, London.
3. Miller, M.D., 1990. Ciguatera Seafood Toxins, CRC Press New York.
4. Carison, V.R. and R.H. Graves, 1996. Aseptic Processing and Packing of Food : A Food Industry Perspective, CRC Press, New York.

5. Gopakumar, K., 1997. Tropical Fishery Products. Oxford & IBH Publications, New Delhi, 190 pp.
6. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fishery Products, Daya Publishing House, New Delhi, 440 pp.
7. Wilson, C.L., S. Droby, 2000. Microbial food contamination, CRC Press, New York.
8. Balachandran,K.K, 2001. Post Harvest Technology of fish and fish products, Daya Publishing House, New Delhi 440 pp.
9. Novak, J.S., G.M. Sapres and V.K. Juneja, 2002. Microbial safety of minimally processed foods, CRC Press, New York.
10. Weidenborner, M., 2003. Encyclopedia of food mycotoxins, Springer Verlag,USA.

Course Outcomes

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

CO1:	To understand the preservation and processing methods and type of preservatives in fish processing.
CO2:	To understand the packing methods, utilization and preparation of fishery by-products.
CO3:	To understand the spoilage of seafood caused by mircroorganisms and their controll measures.
CO4:	To understand the qulality management of fishery products and certification approaches for commerical applications.
CO5:	To understand the product development and nutrition promotion, consumer studies qualitative and quantitative research methods

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
CO5	3	3	3	3	3	3	3
Total	12	15	09	09	15	15	09

19CAQE402 Microbial Technology

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To study the isolation and screening of industrial important microbes and strain development for commercial agents.

LO2: To study the principles of bioprocess technology and optimization for product development.

LO3: To study the recombinant protein product in microbes and their issues in commercial production.

LO4: To study the bioremediation of microbes and their significant role in toxic waste removal and ore leaching.

LO5: To study the application of microbes in food and healthcare industries, food processing and food preservation approaches.

Unit I

Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins.

Unit II

Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products.

Unit III

Recombinant protein production in microbes ; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast)

Unit IV

Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

Unit V

Microbial application in food and healthcare industries; Food processing and food preservation; Antibiotics and enzymes of pharmaceutical use.

REFERENCE BOOKS

1. Peter F. Stanbury, 1999, Principles of Fermentation Technology, Butterworth-Heinemann Publishing, UK, 376 pp.
2. Young M.M ,2004.Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4.., Elsevier India Private Ltd, India.
3. Glazer and Nikaids, 2007, Microbial Biotechnology, 2nd Edition, Cambridge University Press, UK, 576 pp.

Course Outcomes

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

CO1:	To understand the isolation and screening of industrial important microbes and strain development for commercial agents.
CO2:	To understand the principles of bioprocess technology and optimization for product development
CO3:	To understand the recombinant protein product in microbes and their issues in commercial production.
CO4:	To understand the bioremediation of microbes and their significant role in toxic waste removal and ore leaching.
CO5:	To understand the application of microbes in food and healthcare industries, food processing and food preservation approaches.

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

	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	15	12	09	09	15	15	09

19CAQE403 REMOTE SENSING & GIS

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To study the principles and applications of remote sensing and types of sensors and their applications.

LO2: To study the application of remote sensing in the assessment of marine flora and ocean colour monitoring.

LO3: To study the principles and applications of GIS and mapping of marine resources by using the GIS tools.

LO4: To study the spatial Analysis, Integration and modelling strategies and concept of Web GIS.

LO5: To study the marine resources exploration, Mapping and Marine Resources information System.

Unit – I

Introduction to Remote Sensing: Definition of terms, Concepts and types of remote sensing; evolution of remote sensing technology- Electromagnetic spectrum- Atmospheric windows. Types of **Sensors**- passive sensors and active sensors; characteristics of optical sensors; Sensors resolution – spectral, spatial, radiometric and temporal; Thermal Remote sensing, Microwave Remote Sensing and Hyper-spectral Remote Sensing. Satellites and sensors: IRS, Landsat, NOAA, MODIS- LISS, AWIFS, AVHRR, TM, OCM, MODIS and Hypriyan.

Unit – II

Application of remote sensing in the assessment of mangroves, coral reef, seaweed and sea grasses. Ocean Color Monitoring and productivity studies; Sea surface temperature and Oceanographic parameters: eddies, ocean circulation, upwelling and identification of Potential Fishing Zone (PFZ),

Unit- III

Introduction to GIS: Definitions, Basic Concepts, Data- Types and Models: Spatial, Geometrical Data – Raster data, Vector data, Non-spatial, Attribute Data. Advantages

and disadvantages of raster vector data formats. Models of data:- Basic Data Models- raster and vector, Spaghetti model and Topology model; Advanced data models – Grid model, TIN model and DEM.

Map scanning and digitizing, topology building, editing and cleaning. Data processing: Updation, corrections, modifications, scale change, geometric transformations and map projection transformations, conflation sliver removal, edge matching, interactive graphic editing, rubber sheeting.

Unit- IV

Spatial Analysis, Integration and Modelling: Logic operations, general arithmetic operations, general statistical operations, geometric operations, query and report generation from attribute data, geometric data search and retrieval, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay. Definition and concept of Web GIS- advantage and limitations of Web GIS, overview of Web GIS.

Unit V

Applications in Marine sciences: Marine resources exploration, Mapping and Marine Resources information System; GIS in Marine and Coastal Zone Management. Mapping and monitoring of pollution, changes in coastal zones, Applications in Disaster Management: Tsunami – types, causes, RS and GIS applications for post Tsunami damage assessment and rehabilitation. Creating custom GIS Software applications and user interface.

REFERENCE BOOKS

1. Ramachandran, S., 2000. Marine remote sensing applications. Institute for Ocean Management, Anna University.
2. Lillesand, T.M. and R.W. Kefer, 2000. Remote Sensing and image interpretation. John Wiley & Sons. Inc.
3. Anji Reddy, M., 2000. Remote sensing and Geographical Information System. The Book Syndicate, Hydrabad.
4. Lucas, L.F. Janseen, Wim H. Bakker, Ben G.H. Gorte, John A. Horn, Christine Pohl, Anupma Prakash, Colin V. Reeves, Michael J.C. Weir, Tsehaie Woldai, 2001. Principals of Remote Sensing An Introductory Text Box, 2nd edition, ITC Educational Textbook Series.
5. Rolf A de By, Martin C. Wllis, Yola Georgiadou, Wolfgang Kainz, Richard, A. Knippers, Menno-Jan Kraak, Mostafa M. Radwan, Edmund J. Sides, Yuxian Sun, Michael J.C. Weir and Cees J. van Westen, 2001. Principals of Geographic Information Systems: An introductory textbook. 2nd edition. , ITC Educational Textbook Series.
6. Yeqiao, Wang, 2009. Remote Sensing of coastal environments. Taylor & Francis, CRC Press, 457 pp.
7. Michael Kennedy, 2009. Introducing Geographic Information systems with ArcGIS: A workbook approach to learning GIS, 2nd edition, Wiley publications, 624 pp.
8. Pinde Fu and Jiulin Sun, 2010. Web GIS: Principles and Applications. ESRI, 312 pp.
9. Christian Harder, 2011. Understanding GIS: An ArcGIS Project workbook, ESRI, 378 pp.
10. Vasilis, D.Valavanis, 2011. Marine Geographical Information Systems: Theory and Applications (Advances in Geographic Information Science), Springer, 500 pp.

Course Outcomes

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

CO1:	To understand the principles and applications of remote sensing and types of sensors and their applications.
CO2:	To understand the application of remote sensing in the assessment of marine flora and ocean colour monitoring.
CO3:	To understand the principles and applications of GIS and mapping of marine resources by using the GIS tools.
CO4:	To understand the spatial Analysis, Integration and modelling strategies and concept of Web GIS.
CO5:	To understand marine resources exploration, Mapping and Marine Resources information System.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3		3	3		3	3	3		3	3	
CO 2	3		3			3	3	3		3	3	
CO 3	3		3		3	3	3		3	3	3	3
CO 4	3	3				3	3	3	3	3	3	3
CO 5	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	3
CO5	3	3	3	3	3	3	3
Total	15	15	12	09	15	15	09

Inter Departmental Electives (IDE)

19 CAQE 106 Soft Skill Development

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To learn the communications skills, interpreting the verbal and non verbal cues.

LO2: To learn the presentation skills, preparation and participation of group discussions.

LO3: To learn the technical writing skills, preparation of abstract, results, discussion and data interpretation.

LO4: To learn the applications of computer skills browsing search engines Hidden Web and its importance in scientific research.

Unit I: Introduction to Soft Skills

What are soft skills?-What are hard skills?-Importance of soft skills-Importance of knowing yourself-SWOT Analysis and its benefits-Developing positive attitude-Power of positive attitude-overcoming negative attitude.

Unit II: Effective Communication

Meaning of Effective Communication-Verbal and non-verbal communication-Kinesis-Art of Effective Listening-Types of Listening-Barriers to Listening-Advantages of Active Listening- Art of public speech-Language and proficiency in public speech-Spoken English-Fluency-Benefits of Reading-Different types of Reading-Becoming an Effective Reader.

Unit III: Business Communication

Strategies of Good writing-Mechanics of Good writing-use of punctuation-Business letters-Writing Memo-Short reports-Agenda-Minutes-Business Proposals.

Unit IV: Employability Skills

Definition of Interview-Types of Interviews-Typical Questions asked in Interviews-Job Application-CV preparation-Types of Resume-Group Discussion-Essential elements of Group Discussion-Skills required in Group Discussion-Group Discussion Etiquette

Unit V: Professional Skills

Leadership Qualities-Decision making-Time Management-Stress Management-Problem Solving-Team Building and Team work

Supplementary Reading:

- Alex K. *Soft Skills* New Delhi:S.Chand & Co., 2016
- Ghosh,B.N *Managing Soft Skills for Personality Development* New Delhi: Tata McGraw Hill, 2012
- Krishna Mohan and Meera Banarji. *Developing Communication Skills*. New Delhi: Macmillan,2009
- NeeraJain and Shoma Mukherji. *Effective Business Communication*. New Delhi: Tata

McGraw Hill,2012

- Rao, M.S. *Soft Skills-Enhancing Employability*: *Connecting Campus with Corporate*. New Delhi: LK Publishing House, 2011
- Rizwi, Ashraf M. *Effective Technical Communication.* New Delhi : Tata McGraw Hill,2010

Course Outcomes

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

CO1:	To understand the communications skills.
CO2:	To understand the presentation skills, preparation and participation methods.
CO3:	To understand the technical writing skills.
CO4:	To understand the applications of computer and browsing search engines.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3		3	3		3	3	3	3	3	3	
CO 2	3		3			3	3	3		3	3	
CO 3	3		3		3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3		3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	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
Total	12	12	09	09	12	12	06

CO-PO MAPPING SCORES

Courses Impact	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
1	15		6	9	9	15	9
2	15		9				9
3	15		15			9	
4	15				15	15	
5	15	15		9		15	9
6					9	6	9
7	15		6	9		15	9
8	15		6	9		15	9
9	15		9		9	15	
10	15				6	6	9
11	15				15	15	
12	15		9	9	15		9
13	15						9
14	15						
15	15				15		
Total Score	210	15	60	45	93	126	81