UNIVERSITY OF CALICUT

Abstract

General and Academic IV- Faculty of Science- Scheme and Syllabus of B.Sc. Aquaculture Honours Programme -in tune with the CUFYUGP Regulations 2024, with effect from 2024 Admission onwards - Approved-Subject to ratification by the Academic Council-Implemented- Orders Issued

G & A - IV - J

U.O.No. 9141/2024/Admn Dated, Calicut University.P.O, 12.06.2024

Read:-1.U.O.No. 3103/2024/Admn dated 22.02.2024.
2.Minutes of the meeting of the Board of Studies in Aquaculture(SB) held on 12.04.2024.
3.Remarks of the Dean, Faculty of Science dated 04.06.2024.
4. Orders of the Vice Chancellor in the file of even no dated 07.06.2024.

ORDER

1. The Regulations of Calicut University Four Year UG Programmes (CUFYUGP Regulations 2024) for Affiliated Colleges, has been implemented with effect from 2024 admission onwards, vide paper read as (1) .
2. The meeting of the Board of Studies in Aquaculture(SB) held from 12.04.2024, vide paper read as (2) , has approved the Scheme and Syllabus of B.Sc. Aquaculture Honours Programme in tune with CUFYUGP Regulations 2024 with effect from 2024 Admission onwards.
3. The Dean, Faculty of Science vide paper read as (3) ,has approved the minutes of the meeting of the Board of Studies in Aquaculture(SB) held on 12.04.2024.
4. Considering the urgency, the Vice Chancellor has approved the minutes of the meeting of the Board of Studies in Aquaculture(SB) held on 12.04.2024 and accorded sanction to implement the Scheme and Syllabus of B.Sc.Aquaculture Honours programme with effect from 2024 Admission onwards, subject to ratification by the Academic Council.
5. The Scheme and Syllabus of B.Sc.Aquaculture Honours programme in tune with CUFYUGP Regulations 2024, is thus implemented with effect from 2024 Admission onwards.
6. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

1.Principals of all affiliated colleges 2.DR, CDOE
Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/DR, DOA/JCE I/JCE IV/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

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Section Officer

UNIVERSITY OF CALICUT

B.Sc. AQUACULTURE

HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

B.Sc. AQUACULTURE HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, a student would:

PO1	Knowledge Acquisition: Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Communication, Collaboration, Inclusiveness, and Leadership: Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Professional Skills: Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Digital Intelligence: Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Scientific Awareness and Critical Thinking: Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Human Values, Professional Ethics, and Societal and Environmental Responsibility: Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Research, Innovation, and Entrepreneurship: Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO)::

At the end of the BSc Aquaculture program at Calicut University, a student would:

PSO 1	**Expertise in Aquaculture Techniques**: Mastery of various Aquaculture techniques including breeding, nutrition, health management, and advanced skills like molecular diagnostics in aquatic animal health.
PSO 2	**Knowledge of Aquatic Ecosystems**: In-depth understanding of marine and inland fisheries, brackish water Aquaculture, and integrated farming systems.
PSO 3	**Innovation in Aquaculture:** Skills in innovative areas such as aquaponics, Aquaculture engineering, and seafood packaging solutions.
PSO 4	**Sustainability and Ethical Practices**: Proficiency in sustainable fishery management, seafood waste management, and adhering to Aquaculture social responsibility and ethics.
PSO 5	**Entrepreneurial and Business Skills:** Ability to engage in Aquaculture entrepreneurship and understand the dynamics of global seafood trade and market.
PSO 6	**Quality Control and Safety Standards**: Knowledge of seafood quality management systems and Aquaculture certification and standards.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN CUFYUGP

Sl. No.	Academic Pathway	Major	Minor/ Other Disciplines	Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3	Intern-ship	Total Credits	Example
		Each course has 4 credits		Each course has 3 credits			
1	Single Major (A)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Aquaculture and + six courses in different disciplines in different combinations
2	Major (A) with Multiple Disciplines (B, C)	68 (17 courses)	12 + 12 (3 + 3 = 6 courses)	39 (13 courses)	2	133	Major: Aquaculture + Zoology and Biochemistry
3	Major (A) with Minor (B)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Aquaculture and Minor: Zoology
4	Major (A) with Vocational Minor (B)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Aquaculture and Minor: Fish Processing Technology
5	Double Major (A, B)	A: 48 (12 courses) B: 44 (11 courses)	-	12 + 18 + 9	2	133	Aquaculture and Zoology as Majors
			The 24 credits in the Minor stream are distributed between the two Majors. 2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be				

			48 + 20 = 68 (50% of 133) 1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)		
Exit with UG Degree / Proceed to Fourth Year with 133 Credits					

B.Sc. AQUACULTURE HONOURS PROGRAMME

COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	AQC1CJ 101/ AQC1MN 100	Core course1(Major) Fundamentals of Aquaculture (P)	75	5	4	30	70	100
		Minor Course 1	60/ 75	4/ 5	4	30	70	100
		Minor Course 2	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1– English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 1 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
2	AQC2CJ 101/ AQC2MN 100	Core course 2(Major) Foundations of Aquatic biology(P)	75	5	4	30	70	100
		Minor Course 3	60/ 75	4/ 5	4	30	70	100
		Minor Course 4	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3– English	60	4	3	25	50	75

3		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 2 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	AQC3CJ 201	Core course -3 Major Aquaculture Genetics and Biotechnology	60	4	4	30	70	100
	AQC3CJ 202/ AQC3MN 200	Core Course- 4 Major Biology of fishes (P)	75	5	4	30	70	100
		Minor Course 5	60/ 75	4/ 5	4	30	70	100
		Minor Course 6	60/ 75	4/ 5	4	30	70	100
		Multi-Disciplinary Course 3 – Kerala Knowledge System	45	3	3	25	50	75
	ENG3FV 108(2)	Value-Added Course 1 – English	45	3	3	25	50	75
		Total		**23/ 25**	**22**			**550**
4	AQC4CJ 203	Core course -5 in Major Ornamental fish culture and Management (P)	75	5	4	30	70	100
	AQC4CJ 204	Core course-6 in Major Aquaculture Nutrition and Feed Technology (P)	75	5	4	30	70	100
	AQC4CJ 205	Core course -7 in Major Freshwater & Brackish water Aquaculture(P)	75	5	4	30	70	100
	ENG4FV 109(2)	Value-Added Course 2 – English	45	3	3	25	50	75
		Value-Added Course 3 – Additional Language	45	3	3	25	50	75
	ENG4FS 111(2)	Skill Enhancement Course 1 – English	60	4	3	25	50	75
		Total		**25**	**21**			**525**
5	AQC5CJ 301	Core course -8 in Major Mariculture	60	4	4	30	70	100
	AQC5CJ 302	Core course -9 in Major Fishing Techniques and Practices (P)	75	5	4	30	70	100
	AQC5CJ 303	Core course 10 in Major Fish Processing Technology (P)	75	5	4	30	70	100

		Elective Course 1 in Major	60	4	4	30	70	100
		Elective Course 2 in Major	60	4	4	30	70	100
	AQC5FS112	Skill Enhancement Course 2 Academic writing for life science students	45	3	3	25	50	75
		Total		**25**	**23**			**575**
6	AQC6CJ 304/ AQC8MN 304	Core course 11 in Major Aquaculture Engineering and Technology	60	4	4	30	70	100
	AQC6CJ 305/ AQC8MN 305	Core course 12 in Major Biostatistics and Bioinformatics (P)	75	5	4	30	70	100
	AQC6CJ 306/ AQC8MN 306	Core course 13 in Major Fishery Microbiology and Quality control (P)	75	5	4	30	70	100
		Elective Course 3 in Major	60	4	4	30	70	100
		Elective Course 4 in Major	60	4	4	30	70	100
	AQC6FS 113	Skill Enhancement Course 3 Aquatic Specimen Preservation: Techniques and Practices for Museum Collections	45	3	3	25	50	75
	AQC6CJ 349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**
7	AQC7CJ 401	Core course 14 in Major Capture fisheries	60	4	4	30	70	100
	AQC7CJ 402	Core course 15 in Major Instrumentation(P)	75	5	4	30	70	100
	AQC7CJ 403	Core course 16 in Major Live feed culture (P)	75	5	4	30	70	100
	AQC7CJ 404	Core course 17 in Major Fisheries Economics and Extension	60	4	4	30	70	100
	AQC7CJ 405	Core course 18 in Major Seed production and hatchery management	60	4	4	30	70	100
		Total		**22**	**20**			**500**

8	AQC8CJ406/ AQC8MN406	Core course 19 in Major Sea weed Cultivation and Utilization (P)	75	5	4	30	70	100
	AQC8CJ407/ AQC8MN407	Core course 20 in Major Deep Sea Fisheries	60	4	4	30	70	100
	AQC8CJ408/ AQC8MN408	Core Course 21 in Major Fish Population Dynamics	60	4	4	30	70	100
	OR (instead of Core Courses 19 – 21 in Major)							
	AQC8CJ 449	Project (in Honours programme)	360*	13*	12	90	210	300
	AQC8CJ 499	Project (in Honours with Research programme)	360*	13*	12	90	210	300
		Elective Course 5 in Major / Minor Course 7	60	4	4	30	70	100
		Elective Course 6 in Major / Minor Course 8	60	4	4	30	70	100
		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline	60	4	4	30	70	100
	OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme)							
	AQC8CJ 489	Research Methodology	60	4	4	30	70	100
		Total		**25**	**24**			**600**
Total Credits for Four Years					**177**			**4425**

* The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

CREDIT DISTRIBUTION FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Major Courses	Minor Courses	General Foundation Courses	Internship/ Project	Total
1	4	4 + 4	3 + 3 + 3	-	21

2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
* Instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

Distribution of major courses in Aquaculture for pathways 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course code	Name of the course	Hr/week	Credit
1	AQC1CJ101/ AQC1MN100	Core course 1 in Major Fundamentals of Aquaculture (P)	5	4
2	AQC2CJ101/ AQC2MN100	Core course 2 in Major Foundations of Aquatic biology(P)	5	4
3	AQC3CJ201	Core course 3 in Major Aquaculture Genetics and Biotechnology	4	4
	AQC3CJ202/ AQC3MN200	Core course 4 in Major Biology of Fishes (P)	5	4
4	AQC4CJ203	Core course 5 in Major Ornamental Fish Culture and Management (P)	5	4
	AQC4CJ204	Core course 6 in Major Aquaculture Nutrition and Feed Technology (P	5	4
	AQC4CJ205	Core course 7 in Major Freshwater & Brackish water Aquaculture(P)	5	4
5	AQC5CJ301	Core course 8 in Major Mariculture	4	4
	AQC5CJ302	Core course 9 in Major Fishing Techniques and Practices (P)	5	4
	AQC5CJ303	Core course 10 in Major Fish Processing Technology (P)	5	4
		Electives		
		Elective Course 1 in Major	4	4
		Elective Course 2 in Major	4	4
	AQC6CJ304/	Core course 11 in Major Aquaculture Engineering	4	4

6	AQC8MN304	and Technology		
	AQC6CJ305/ AQC8MN305	Core course 12 in Major Biostatistics and Bioinformatics (P)	5	4
	AQC6CJ306/ AQC8MN306	Core course 13 in Major Fishery Microbiology and Quality Control (P)	5	4
		Electives		
		Elective Course 3 in Major		4
		Elective Course 4 in Major		4
		Internship		2
		Total for 3 years		**70**
7	AQC7CJ401	Core course 14 in Major Capture Fisheries	4	4
	AQC7CJ402	Core course 15 in Major Instrumentation (P)	5	4
	AQC7CJ403	Core course 16 in Major Live Feed Culture (P	5	4
	AQC7CJ404	Core course 17 in Major Fisheries Economics and Extension	4	4
	AQC7CJ405	Core course 18 in Major Seed production and hatchery management	4	4
8	AQC8CJ406/ AQC8MN406	Core course 19 in Major Seaweed Cultivation and Utilization(P)	5	4
	AQC8CJ407/ AQC8MN407	Core course 20 in Major Deep Sea Fisheries	4	4
	AQC8CJ408/ AQC8MN408	Core course 21 in Major Fish Population Dynamics	4	4
		Or OR (instead of Core Courses 19 – 21 in Major)		
	AQC8CJ 449	Project (in Honours programme)	13	12
	AQC8CJ 499	Project (in Honours with Research programme)	13	12
		Elective Course 5 in Major	4	4
		Elective Course 6 in Major	4	4
		Elective Course 7 in Major	4	4
	OR (instead of Elective course 7 in Major, in Honours with Research programme)			
	AQC8CJ 489	Research Methodology	4	4
		TOTAL		114

Elective courses in Aquaculture with no specialisation

Course Code	Name of the course	Total hours	Hours per week	Credit	Marks		
					Internal	External	Total
AQC5EJ 301	Aquaponics and Integrated Farming Systems	60	4	4	30	70	100
AQC5EJ 302	Climate change and Aquatic resources	60	4	4	30	70	100

AQC5EJ 303	Blue economy and Aquaculture	60	4	4	30	70	100
AQC 5EJ 304	Fish Biochemistry	60	4	4	30	70	100
AQC6EJ 305	Aquatic Animal Health and Disease Management	60	4	4	30	70	100
AQC6EJ 306	Sustainable Aquaculture Practices	60	4	4	30	70	100
AQC6EJ 307	Aquatic Ecology and Conservation in Aquaculture	60	4	4	30	70	100
AQC 6EJ 308	Aquaculture farm Management	60	4	4	30	70	100
AQC8EJ 401	Endocrinology of Fish	60	4	4	30	70	100
AQC8EJ 402	Fish Immunology	60	4	4	30	70	100
AQC8EJ 403	Organic Aquaculture	60	4	4	30	70	100
AQC8EJ 404	Fisheries Oceanography	60	4	4	30	70	100
AQC8EJ 405	Aquatic Pollution and Toxicology	60	4	4	30	70	100
AQC8EJ 406	Fisheries business management	60	4	4	30	70	100

Minor courses in Aquaculture

Tile of the course - Minor in Aquaculture

Note-*Minor courses given below should not be offered to students who have taken Aquaculture as major Discipline. They should be offered to select from other Major Disciplines*

Group1 Aquaculture systems and Management

	Name of the course	Total hours	Hours per week	Credit	Marks		
					Internal	External	Total
AQC1MN101	Introduction to Aquaculture	75	5	4	30	70	100
AQC2MN101	Aquaculture Disease Management	75	5	4	30	70	100
AQC3MN201	Aquaculture Production Systems	75	5	4	30	70	100

Group 2 ***Seafood Safety and Trade***

	Name of the course	Total hours	Hours per week	Credit	Marks		
					Internal	External	Total
AQC1MN102	Introduction to Seafood Quality Control	75	5	4	30	70	100
AQC2MN102	Fundamentals of Seafood Trade	75	5	4	30	70	100
AQC3MN202	Seafood Quality Management Systems	75	5	4	30	70	100

Grouping of Vocational Minor Courses

Title of the course –Applied Fisheries

Note- ***Vocational Minor courses given below should not be offered to students who have taken Aquaculture as major Discipline. They should be offered to select from other Major Discipline***

	Name of the course	Total hours	Hours per week	Credit	Marks		
					Internal	External	Total
Group 1 Commercial Production of Ornamental fishes							
AQC1VN 101	Ornamental Fish Breeding Techniques	75	5	4	30	70	100
AQC2VN101	Aquarium Systems and Management	75	5	4	30	70	100
AQC3VN201	Health Management in Ornamental Fish	75	5	4	30	70	100
AQC8VN301	Business Aspects of Ornamental Fish Trade	75	5	4	30	70	100
Group 2 Fish Processing Technology							
AQC1VN 102	Fundamentals of Fish Processing	75	5	4	30	70	100
AQC2VN 102	Seafood Safety and Quality Control	75	5	4	30	70	100
AQC3VN 202	Value-Added Fish Products Development	75	5	4	30	70	100
AQC8VN 302	Advanced Packaging and Preservation Techniques	75	5	4	30	70	100

(i). Students in Single Major pathway can choose course/courses from any of the Minor/ Vocational Minor groups offered by a discipline other than their Major discipline.

(ii). Students in Major with Multiple Disciplines pathway can choose as one of the multiple disciplines, all the three courses from any one of the Minor/ Vocational Minor groups offered by any discipline, including their Major discipline. If they choose one of the Minor/ Vocational Minor groups offered by their Major discipline as the first one of the multiple disciplines, then their choice as the second one of the multiple disciplines should be any one of the Minor/ Vocational Minor groups offered by a discipline other than the Major discipline. If the students choose any one of the Minor/ Vocational Minor groups in Aquaculture as given above, then the title of the group will be the title of that multiple discipline.

(iii). Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline.

(iv). Students in Major with Vocational Minor pathway can choose all the courses from any two Vocational Minor groups offered by any discipline.

DISTRIBUTION OF GENERAL FOUNDATION COURSES

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	AQC1FM 105	MDC-1Fish as Food: Nutrition and Beyond"	45	3	3	25	50	75
2	AQC2FM 106	MDC-2 Marine Biodiversity &Conservation	45	3	3	25	50	75
3	AQC3FV 108	VAC1Ecotourism	45	3	3	25	50	75
4	AQC4FV 110	VAC2 Environmental Impact Assessment	45	3	3	25	50	75
5	AQC5FS 112	SEC-2Academic writing for life science students	45	3	3	25	50	75
6	AQC6FS 113	SEC-3 Aquatic Specimen Preservation: Techniques and Practices for Museum Collections	45	3	3	25	50	75

COURSE STRUCTURE FOR BATCH A1(B2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Aquaculture (Major A) ***B1: 68 credits in Major B***

A2: 53 credits Aquaculture (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	AQC1CJ 101 / AQC1MN 100	Core course1(Major) Fundamentals of Aquaculture (P)	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	AQC1CJ 102 / AQC2CJ 102 / AQC4CJ 205*	Core Course 2 in Major Freshwater & Brackish water Aquaculture(P)	75	5	4	30	70	100
	ENG1FA 101(2)	AEC1 – English	60	4	3	25	50	75
		AEC 2 – Additional Language	45	3	3	25	50	75
	AQC1FM 105	MDC-1Fish as Food: Nutrition and Beyond	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
2	AQC2CJ 101 / AQC2MN 100	Core course 3 in Major Foundations of Aquatic biology(P)	75	5	4	30	70	100
	BBB2CJ 101	Core Course 2 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB2CJ 102 / BBB1CJ 102	Core Course 3 in Major B – (for batch B2 only)	60/ 75	4/ 5	4	30	70	100

	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
	AQC2FM 106 / AQC3FM 106	MDC-2 Marine Biodiversity &conservation	45	3	3	25	50	75
		Total		**23 – 25**	**21**			**525**
3	AQC3CJ 201	Core Course 4 in Major Aquaculture Genetics and Biotechnology	60	4	4	30	70	100
	AQC3CJ 202 / AQC3MN 200	Core Course 5 in Major Biology of Fishes (P)	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	Multi-Disciplinary Course 1 in B –	45	3	3	25	50	75
	AQC3FV 108	VAC1Ecotourism	45	3	3	25	50	75
		Total		**23 – 25**	**22**			**550**
4	AQC4CJ 203	Core Course 6 in Major Ornamental Fish Culture and Management	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
	AQC4CJ 204	Core course 7 in Major Aquaculture Nutrition and Feed Technology (P)	75	5	4	30	70	100
	AQC4FV 110	VAC2 Environmental Impact Assessment	45	3	3	25	50	75
	BBB4FV 110	Value-Added Course 1 in B –	45	3	3	25	50	75
	AQC4FS 112 / AQC5FS 112	SEC-1 in Aquaculture -Academic writing for life science students	45	3	3	25	50	75

		Total		**23/ 24**	**21**			**525**
5	AQC5CJ 302	Core course 8 in Major Fishing Techniques and Practices (P)	75	5	4	30	70	100
		Core Course 7 in Major B –	60/ 75	4/ 5	4	30	70	100
	AQC5CJ 303	Core Course 9 in Major Fish Processing Technology (P) (for batch A1 only)	60	4	4	30	70	100
		Elective Course 1 in Major Aquaculture	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	Skill Enhancement Course 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	AQC6CJ 305/ AQC8MN 305	Core Course 10 in Major Biostatistics and Bioinformatics (P)	75	5	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB6CJ 305	Core Course 9 in Major B – (for batch B2 only)	60	4	4	30	70	100
		Elective Course 2 in Aquaculture	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	AQC6FS 113	SEC-2 Aquatic Specimen Preservation: Techniques and Practices for Museum Collections	45	3	3	25	50	75
	AQC6CJ 349	Internship in Major Aquaculture (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**
For batch A1(B2), the course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6.								

* The course code of the same course as used for the pathways 1 – 4

CREDIT DISTRIBUTION FOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in Aquaculture	General Foundation Courses	Internship/ Project	Major Courses in B	General Foundation Courses in B	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	3	-	4 + 4	-	3 + 3	21
3	4 + 4	3	-	4 + 4	3	-	22
4	4 + 4	3 + 3	-	4	3	-	21
5	4 + 4 + 4	-	-	4 + 4	3	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in Aquaculture	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
* Instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

COURSE STRUCTURE FOR BATCH B1(A2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Aquaculture (Major A) ***B1: 68 credits in Major B***

A2: 53 credits Aquaculture (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

Semester	**Course Code**	**Course Title**	**Total Hours**	**Hours/ Week**	**Credits**	**Marks**		
						Internal	**External**	**Total**
1	AQC1CJ 101 / AQC1MN 100	Core course 1 in Major Fundamentals of Aquaculture (P)	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB1CJ 102 / BBB2CJ 102	Core Course 2 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	BBB1FM 105	Multi-Disciplinary Course 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**21**			**525**
2	AQC2CJ 101 / AQC 2MN 100	Core course 2 in Major Foundations of Aquatic biology(P)	75	5	4	30	70	100
	BBB2CJ 101	Core Course 3 in Major B –	60/ 75	4/ 5	4	30	70	100

	AQC2CJ 102 / AQC1CJ 102 / AQC4CJ 205*	Core Course 3 in Major Freshwater & Brackish water aquaculture(P)	75	5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
	AQC2FM 106 / AQC3FM 106	Multi-Disciplinary Course 1 Marine Biodiversity &conservation n	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
3	AQC3CJ 201	Core Course 4 in Major Aquaculture Genetics and Biotechnology	60	4	4	30	70	100
	AQC3CJ 202 / AQC3MN 200	Core Course 5 in Major Biology of Fishes (P)	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	Multi-Disciplinary Course 2 in B	45	3	3	25	50	75
	BBB3FV 108	Value-Added Course 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**22**			**550**
4	AQC4CJ 203	Core Course 6 in Major Ornamental Fish Culture and Management	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
		Core Course 7 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100

	AQC4FV 110	VAC 1 Aquaculture-Environmental Impact Assessment	45	3	3	25	50	75
	BBB4FV 110	Value-Added Course 2 in B –	45	3	3	25	50	75
	AQC4FS 112 / AQC5FS 112	SEC-1 in Aquaculture Academic writing for life science students	45	3	3	25	50	75
		Total		**22 – 24**	**21**			**525**
5	AQC5CJ 302	Core course 7 in Major Fishing Techniques and Practices (P)	75	5	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
		Core Course 9 in Major B – (for batch B1 only)	60	4	4	30	70	100
		Elective Course 1 in Major Aquaculture	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	Skill Enhancement Course 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	AQC6CJ 305/ AQC8MN 305	Core Course 8 in Major Biostatistics and Bioinformatics (P	75	5	4	30	70	100
		Core Course 10 in Major B –	60/ 75	4/ 5	4	30	70	100
	AQC6CJ 306/ AQC8MN 306	Core course 9 in Major Fishery Microbiology and Quality control (P	60	4	4	30	70	100
		Elective Course 2 in Major Aquaculture	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	BBB6FS 113	Skill Enhancement Course 2 in B – (for batch B1 only)	45	3	3	25	50	75

	BBB6CJ 349	Internship in Major B (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**
To continue to study Aquaculture in semesters 7 and 8, batch B1 (A2) needs to earn additional 15 credits in Aquaculture to make the total credits of 68. Suppose this condition is achieved, and the student of batch B1(A2) proceeds to the next semesters to study Aquaculture. The course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6, taking into account the number of courses in Aquaculture taken online to earn the additional 15 credits.								

* The course code of the same course as used for the pathways 1 – 4

CREDIT DISTRIBUTION FOR BATCH B1 (A2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in B	General Foundation Courses in B	Internship/ Project in B	Major Courses in Aquaculture	General Foundation Courses in Aquaculture	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	-	-	4 + 4	3	3 + 3	21
3	4 + 4	3 + 3	-	4 + 4	-	-	22
4	4 + 4	3	-	4	3 + 3	-	21
5	4 + 4 + 4	3	-	4 + 4	-	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in B	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
* Instead of three Major courses							
Total for Four	**88 + 12 = 100**	**12**					**177**

Years							

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
   - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
   - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.
3. All the 3-credit courses (General Foundational Courses) in Aquaculture are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course	Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
		Open-ended module / Practical	On the other 4 modules		

1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
		20	10	10	20*
	Total	30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.

- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5)

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
				Total Marks	70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Aquaculture or allied disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. In BSc. Aquaculture Honours programme, institute/ industry visit or study tour is a requirement for the completion of Internship. Visit to minimum one national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the study tour has to be submitted with photos and analysis.
5. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
6. The log book and the typed report must be submitted at the end of the Internship.
7. The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 2 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	10	40%
2		Interim Presentation and Viva-voce	5	
3		Punctuality and Log Book	5	
4	Report of Institute Visit/ Study Tour		5	10%
5	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	6	35%
6		Presentation of the work	5	
7		Viva-voce	6	
8	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		8	15%
	Total Marks		50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.

- The Project can be done in the same institution/ any other higher educational institution (HEI)/ research centre/ training centre.
- The Project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ ST/ OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.

- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Aquaculture or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental on non-experimental
4. There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as in Honours with Research programme.
5. There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme.
6. The various steps in project works are the following:
   - Wide review of a topic.
   - Investigation on a problem in systematic way using appropriate techniques.
   - Systematic recording of the work.
   - Reporting the results with interpretation in a standard documented form.
   - Presenting the results before the examiners.
7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.

10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	90	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce	60	20%

examination conducted by the external examiner		
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research) 12 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Aquaculture are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General	Internal Marks of a General Foundation Course of 3-credits in Aquaculture

	Foundation Course in Aquaculture	4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
		20	5
	Total	25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

5. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student’s performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External	Description	Letter Grade	Grade Point	Range of Grade	Class

	Put Together)				Points	
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):

  The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

  $$\text{i.e. SGPA (Si)} = \Sigma i\,(Ci \times Gi) / \Sigma i\,(Ci)$$

  where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$\text{SGPA} = \frac{\text{Sum of the credit points of all the courses in a semester}}{\text{Total credits in that semester}}$$

ILLUSTRATION – COMPUTATION OF SGPA

Semester	Course	Credit	Letter Grade	Grade point	Credit Point (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in six semesters}}{\text{Total credits in six semesters (133)}}$$

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

$$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in eight semesters}}{\text{Total credits in eight semesters (177)}}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

UNIVERSITY OF CALICUT

B.Sc. AQUACULTURE

HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

Ist Semester Major Core Course

Programme	B. Sc. Aquaculture Honours					
Course Title	Fundamentals of Aquaculture					
Type of Course	**Major** core					
Semester	I					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A pass in HSE/VHSC or Equivalent with biology					
Course Summary	This course introduces the principles and practices of aquaculture. Students will learn about fish biology, water quality management, various aquaculture systems, sustainability and environmental impacts, economic aspects, and practical skills in aquaculture management.					

Course Outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic principles of aquaculture, including fish biology and water quality management.	(U)	(F)	Instructor-created exams , Quiz
CO2	Identify and describe various aquaculture systems and practices.	R	C	Instructor-created exams Seminar presentations
CO3	Apply aquaculture techniques for breeding, rearing, and harvesting aquatic organisms.	Ap	P	Practical Assignment Observation of practical skills Instructor-created exams
CO4	Analyse case studies to evaluate the sustainability and environmental impact of aquaculture practices.	An	M	In-class discussions, Instructor-created exams Assignments
CO5	Evaluate the economic aspects of aquaculture, including market trends and business planning.	E	C	Oral presentation Instructor-created exams \Assignment
CO6	Create a comprehensive aquaculture management plan that incorporates best practices	C	P	Project or Plan Submission Seminar presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed syllabus

Module	Unit	Content	Hrs
I	**Introduction to Aquaculture**		**10**
	1	Overview of Aquaculture Industry	2
	2	History and Development of Aquaculture	3
	3	Basic Principles of Fish Biology	3
	4	Significance of Aquaculture in Global Food Security	2
II	**Aquaculture Systems and Practices**		**10**
	5	Types of Aquaculture Systems (Extensive, Intensive, Integrated)	3
	6	Water Quality Management	3
	7	Feed and Nutrition in Aquaculture	2
	8	Disease Control and Health Management	2
III	**Breeding and Rearing Techniques**		**15**
	9	Principles of Fish Breeding	2
	10	Hatchery Management	2
	11	Rearing Techniques for Different Aquatic Species	1
	12	Stocking and Harvesting Methods	2
	13	Understanding genetic principles in fish breeding	2
	14	Techniques of selective breeding for desirable traits	2
	15	Criteria for broodstock selection	1
	16	Ethical considerations in breeding programs	1
	17	Role of biotechnology in fish breeding	2
IV	**Sustainability and Economics in Aquaculture**		**10**
	18	Environmental Impact of Aquaculture Practices	2
	19	Sustainable Aquaculture Techniques	2
	20	Market Trends and Trade in Aquaculture	2
	21	Business Planning and Economics of Aquaculture Operations	2
	22	Aquaculture Certification and ecolabelling	2
V	**Practical Applications in Aquaculture (Practical Module)**		**30**
	1	• Testing pH, dissolved oxygen, ammonia, nitrates, and temperature in water samples • Demonstrations and practice of fish netting, transport, and sedation. • Microscopic examination of fish scales and gills for parasites, discussion on common fish diseases • Demonstration of spawning techniques, egg collection, and incubation. • Preparation of different types of fish feeds .	20
	2	Field visit- Visit to a Local Aquaculture Farm	7
	3	Identification of cultivable aquatic organisms	3

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	1	2	1	2	3	2	1	-	2	-	1
CO 2	3	3	2	2	2	2	2	3	-	2	1	-	2
CO 3	3	-	2	2	2	2	3	3	2	3	-	3	1
CO 4	-	2	-	3	-	2	2	2	3	1	3	2	3
CO 5	-	-	2	-	3	-	1	2	-	2	3	1	2
CO 6	3	2	3	3	3	3	3	3	2	3	2	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1			✓	✓
CO 2			✓	✓
CO 3			✓	✓
CO 4	✓			✓
CO 5	✓			✓
CO 6		✓		

Suggested reading

1. Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C. Southgate
2. "Principles of Aquaculture" by Robert R. Stickney
3. Aquaculture Science" by Rick Parker
4. "Aquaculture: Principles and Practices" by T.V.R. Pillay and M.N. Kutty
5. Recirculating Aquaculture" by Michael B. Timmons and James M. Ebeling
6. Aquaponics Food Production Systems" edited by Simon Goddek et al.
7. Disease in Aquaculture: Prevention and Control" by Malcolm Jobling
8. Sustainable Aquaculture Techniques" edited by Martha Patricia Hernandez-Vergara and Carlos Ivan Perez-Rostro
9. Nutrition and Feeding of Fish and Crustaceans" by Jean Guillaume, Sadasivam J. Kaushik, and Pierre Bergo

IInd Semester MajorCore Course

Programme	B. Sc. Aquaculture Honours					
Course Title	Foundations of Aquatic Biology					
Type of Course	**Major** Core					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	3	-	2	75	2hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The Foundations of Aquatic Biology course offers an in-depth exploration of aquatic ecosystems, covering their properties, diverse life forms, ecological dynamics, and research methods, equipping students with the knowledge to study and conserve aquatic environments.					

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the history, scope, and importance of aquatic biology in aquaculture.	U	C	Written exams, quizzes
CO2	Grasp the characteristics and diversity of aquatic ecosystems and life forms.	U	C	Quizzes, lab reports
CO3	Apply knowledge of physical and chemical water properties to assess their influence on aquatic life.	Ap	P	Practical exams, lab reports
CO4	Analyze trophic dynamics, nutrient cycles, and ecological interactions within aquatic environments.	An	P	Case studies, project reports
CO5	Evaluate the impact of human activities and climate change on aquatic systems and explore conservation strategies.	E	C	Research projects, presentations
CO6	Develop skills in scientific research methods, data analysis, and experimental design specific to aquatic biology.	C	P	Lab practicals, field studies, seminar presentations

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus: Foundations of Aquatic Biology

Module	Unit	Content	Hrs
I	**Introduction to Aquatic Environments**		**10**
	1	Overview of Aquatic Sciences - History, scope, and importance of aquatic biology in aquaculture.	2
	2	Aquatic Ecosystems - Characteristics and types of freshwater and marine ecosystems	3
	3	Physical Properties of Water - Temperature, light, density, and how they influence life in water	3
	4	Chemical Properties of Water - Salinity, pH, dissolved oxygen, and their biological significance	2
II	**Diversity of Aquatic Life**		**10**
	5	Phytoplankton and Algae - Role in ecosystems, types, and their ecological significance.	3
	6	Aquatic Plants and Macrophytes - Adaptations to aquatic life, importance in habitats	3
	7	Invertebrates in Aquatic Systems - Diversity, ecological roles, and life cycles	2
	8	Fish and Aquatic Vertebrates - Diversity, adaptations to aquatic living, and their ecological impact	2
III	**Aquatic Ecology and Environmental Interactions**		**15**
	9	Trophic Dynamics - Food webs, primary and secondary productivity.	2
	10	Nutrient Cycles - Nitrogen, phosphorus cycles in aquatic systems	2
	11	Population Ecology - Concepts of population dynamics in aquatic environments.	1
	12	Community Ecology - Biotic interactions, habitat structure, and biodiversity.	2
	13	Aquatic Microbial Ecology - Role of microorganisms in aquatic environments	2
	14	Ecological Succession in Aquatic Habitats - Concepts and example	2
	15	Human Impacts on Aquatic Systems - Pollution, eutrophication, and habitat destruction	1
	16	Climate Change and Aquatic Environments - Effects and adaptations	1
	17	Conservation and Restoration Ecology - Strategies for aquatic conservation and management	2
IV	**Research Methods and Data Analysis in Aquatic Biology**		**10**
	18	Scientific Method in Aquatic Research - Hypothesis development, experimental design.	2
	19	Sampling Techniques in Aquatic Environments - Methods for water, sediment, and biota.	2
	20	Analytical Techniques - Water quality analysis, biological assays.	2
	21	Data Analysis and Interpretation - Statistical techniques, software tools.	2
	22	Writing and Presenting Scientific Research - Structure of scientific papers, presentation skills.	2
V	**Practical Module**		**30**
	1	Laboratory Safety and Basic Equipment Use - Introduction to laboratory protocols and equipment handling.	20

		Water Quality Analysis - Practical exercises on measuring pH, dissolved oxygen, salinity, and nutrients. Sampling and Identification of Aquatic Organisms - Techniques for collecting and identifying phytoplankton, zooplankton, aquatic plants, and fish.	
	2	Field Methods in Aquatic Ecology - Design and execution of field studies, including habitat assessment and ecological survey techniques.	5
	3	Experimental Aquaculture - Setting up and maintaining aquaculture experiments to study growth, feeding, and breeding of aquatic species.	5

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	2	3	2	2	3	2	2	1	3	3	2
CO 2	3	3	2	3	2	2	3	2	2	1	3	3	2
CO 3	3	3	3	3	2	3	3	2	3	2	3	3	2
CO 4	2	3	3	3	3	3	2	2	3	2	3	3	3
CO 5	2	3	3	3	3	3	2	3	3	2	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. Marine Biology" by Peter Castro and Michael E. Huber
2. Introduction to the Biology of Marine Life" by John Morrissey and James L. Sumich
3. Marine Biology: Function, Biodiversity, Ecology" by Jeffrey S. Levinton
4. "Marine Biology: An Ecological Approach" by James W. Nybakken and Mark D. Bertness
5. Essentials of Oceanography" by Alan P. Trujillo and Harold V. Thurman
6. Freshwater Ecology: Concepts and Environmental Applications of Limnology" by Walter K. Dodds and Matt R. Whiles
7. Aquatic Ecology: A Textbook for Students" by J.I. Furtado
8. "Ecology of Aquatic Systems" by Mike Dobson and Chris Frid
9. "Limnology: Lake and River Ecosystems" by Robert G. Wetzel

IIIrd Semster Major Core Courses

Programme	B. Sc. Aquaculture Honours
Course Title	Aquaculture Genetics and Biotechnology
Type of Course	**Major** Core
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4		0	60	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology .Should have completed previous semesters
Course Summary	This overview covers the fundamental distinctions between cell types and genetics, and extends into aquaculture biotechnology, focusing on genetic modifications, breeding, and biotechnological strategies for sustainable aquaculture improvement.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the structural and functional differences between prokaryotic and eukaryotic cells, including an overview of cell organelles and their significance in the diversity of life.	U	F	Written exams, quizzes
CO2	Understand the processes of cell division, specifically mitosis and meiosis, and grasp foundational genetic principles including Mendel's laws, gene interactions, and inheritance patterns."	U	C	Written exams, quizzes, assignments
CO3	Apply knowledge of chromosomal aberrations, mutations, and genetic modifications to understand their implications in biotechnology and aquaculture.	Ap	P	Lab reports, practical exams
CO4	.Apply selective breeding, hybridization techniques, and the use of genetic markers and GMOs in aquaculture for improved production and sustainability.	Ap	P	Project work, presentations
CO5	Apply biotechnological tools in managing aquatic animal health, encompassing molecular diagnostics, vaccine development,	Ap	P	Case studies, lab practicals

	and the use of probiotics and prebiotics.			
CO6	Evaluate and create innovative solutions for challenges in aquaculture biotechnology, including genetic improvements, bioremediation, and enhancing the nutritional value of aquaculture products.	E, C		Research projects, seminar presentatio
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I		**Fundamentals of cell Biology**	**10**
	1	Introduction to the fundamental differences between prokaryotic and eukaryotic cells, setting the stage for the complexity and diversity of life at the cellular level. An over view of different organelles of eukaryotic cell	2
	2	The Command Centre The Nucleus and Chromosomes.	3
	3	Powerhouse and Photosynthesis Factories: Mitochondria and Chloroplasts and other organells	3
	4	Cell division – Mitosis and meiosis	2
II		**Basic Genetics**	**10**
	5	Mendel's law of inheritance. Gene interactions	3
	6	Complete, incomplete and co-dominance, multiple alleles, linkage	2
	7	Chromosomal aberrations: Monosomy, trisomy.	2
	8	Mutations and mutagens. Translocations, inversions, duplications, deletions	3
III		**Aquaculture Biotechnology**	**20**
	9	Selective Breeding and Hybridization Techniques	2
	10	Genetic Markers and Their Applications	2
	11	Transgenic Fish and GMOs in Aquaculture:	2
	12	Recombinant DNA technology	2
	13	Biotechnological tools for aquaculture,	2
	14	Chromosome manipulation in fish and shell fishes- Triploidy, Polyploidy, Gynogenesis, Androgenesis	3
	15	Monosex production, super male and super female fish production techniques.	3
	16	Synthetic hormone production for induced breeding	2
	17	Cryopreservation	2
IV		**Biotechnology for Aquatic Animal health Management**	**8**
	18	Molecular diagnostics, immunological techniques, and their applications in disease detection	2
	19	Development and application of vaccines and immunostimulants for disease prevention.	2

	20	Application of probiotics and prebiotics in improving gut health and disease resistance.	2
	21	Strategies and technologies for maintaining biosecurity and minimizing environmental impacts.	1
	22	Biotechnological approaches to waste management and water quality improvement in aquaculture systems.	1
V	**Open Ended Module:**		**12**
	1	Recent Developments in Aquaculture Biotechnology Genetic improvements of Native species	
	2	Bioremediation in Aquaculture Ponds:	
	3	Application of biotechnology in enhancing the productivity and nutritional value of mussels and oysters	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	-	-	2	-	1	2	3	1	-
CO 2	3	2	1	-	-	-	3	-	2	1	3	-	1
CO 3	3	3	2	2	1	2	3	1	3	2	3	2	1
CO 4	3	3	3	3	2	3	3	2	3	3	3	3	3
CO 5	3	3	3	3	1	3	3	3	3	3	3	3	2
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1			✔	✔
CO 2			✔	✔
CO 3	✔			✔
CO 4	✔	✔		✔
CO 5	✔	✔		✔
CO 6	✔	✔	✔	✔

Suggested reading

1."Molecular Biology of the Cell" by Bruce Alberts et al.

2. "Genetics: A Conceptual Approach" by Benjamin A. Pierce

3."Introduction to Genetic Analysis" by Anthony J.F. Griffiths et al.

4."Aquaculture Biotechnology" by Garth L. Fletcher and Matthew L. Rise

5."Biotechnology and Genetics in Fisheries and Aquaculture" by Andy Beaumont and Kate Hoare

6."Principles of Aquaculture" by Robert R. Stickney

Programme	B. Sc. Aquaculture Honours
Course Title	Biology of fishes
Type of Course	**Major** core
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	3	-	2	75	2

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	This course offers a comprehensive overview of ichthyology, encompassing fish biology, taxonomy, physiology, and practical aspects of aquaculture. It integrates theoretical knowledge with hands-on experiments and specimen collection, focusing on nutrition, growth, reproduction, endocrinology, and sustainable aquaculture practices.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Identify and classify different fish species and understand their morphological characteristics.	U	F	Quizzes Assignments Identification tests
CO2	Analyze and interpret fish feeding habits, growth patterns, and reproductive mechanisms	An	C	Case studies, Analysis reports, Practical demonstrations
CO3	Apply methods for assessing fish health, including examination of gill structures and alimentary canals.	Ap	p	Practical exams, Lab exercises, Fieldwork
CO4	Evaluate the impact of different environmental conditions on fish physiology and behaviour.	E	M	Research projects, Group discussions, Seminar presentation
CO5	Apply practical skills in collecting fish specimens and conducting experiments to explore aspects of fish biology."	Ap	p	Hands-on lab work, Field trips, Experiment reports
CO6	Analyse the roles of fish endocrinology and excretion in aquaculture to understand their implications for fish health and farm management	An	C	Theses, Synthesis papers, Conceptual mappings

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Fundamentals of Ichthyology and Fish Biology**		**10**
	1	General characteristics of fishes, adaptations, body forms, fins, skin, scales, coloration	2
	2	Bioluminescence, sense organs, specialized organs	3
	3	Principles of zoological classifications,	3
	4	Binomial nomenclature of important aquatic species.	2
II	**Nutrition and Growth in Aquatic Organisms**		**10**
	5	Feeding habits, feeding adaptations,	3
	6	Gut content analysis	3
	7	Age and growth techniques, growth rates.	2
	8	Basic nutritional requirements and dietary variations across different aquatic species.	2
III	**Reproduction, Migration, and Physiology**		**15**
	9	Reproduction mechanisms	2
	10	Sexual dimorphism	1
	11	Spawning, fecundity	1
	12	Reproductive biology of Shell fishes	2
	13	Migration types	2
	14	Respiratory systems	2
	15	Cardiovascular system.	2
	16	Digestive system	2
	17	Immune system in fish	1
IV	**Endocrinology, Excretion, and Applied Aquaculture**		**10**
	18	Endocrine organs, hormones.	2
	19	Excretion, osmoregulation	2
	20	Hormonal control in aquaculture practices	2
	21	Water and salt balance.	2
	22	Endocrinology of Shell fishes	2
V	**Practical Applications in Aquaculture (Practical Module)**		**30**
	1	Experiments: Morphometric measurements of fishes. Fin forms of fishes and swimming behaviour. Types of scales: placoid, cycloid, and ctenoid. Examination of gill structure and feeding behaviour assessment in Sardinella/Channa sp. Mounting of appendages of Prawn. Dissection and display of alimentary canal of fishes/prawns. Fecundity estimation in fishes/prawn and its relationship with length and weight. Gut content analysis using volumetric methods .	20
	2	Collection: Fishes with different caudal fin forms. Fish with various mouth adaptations. Fish with different alimentary canal lengths. Fish with different types of scales.	10

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	-	-	-	-	2	3	1	-	2	-	1
CO 2	2	3	1	1	-	-	3	2	3	2	1	3	2
CO 3	3	1	-	2	-	2	3	3	2	3	2	3	1
CO 4	1	3	2	3	-	1	3	2	3	1	3	2	3
CO 5	3	2	3	2	1	-	2	3	2	3	2	3	1
CO 6	2	-	2	1	2	3	3	2	3	2	1	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔			✔
CO 2	✔	✔		
CO 3		✔	✔	
CO 4			✔	✔
CO 5	✔	✔		
CO 6			✔	✔

Suggested reading

1. Fishes: An Introduction to Ichthyology by Moyle, P.B. and Cech, J.J.
2. A History of Fishes by Norman, J.R.
3. Methods of Fish Production in Freshwaters by Bagenal
4. Ecology of Fishes by Nicholski, G.V.
5. Ichthyology by Lagler
6. Fish Physiology by Matty
7. Fishes of India by Francis Day
8. The Marine and Freshwater Fishes of Ceylon by Munro, I.S.R.
9. The Commercial Molluscs of India by CMFRI

Supplementary Reading:

1. The Biology of Mollusca by Purchon, R.D.
2. The Biology of Crustacea by Dorothy E. Bliss
3. (It appears the title or further information for Nelson, J.S. was not provided. Please specify for completion.)

IVth Semester Major Core Courses

Programme	B. Sc. Aquaculture Honours					
Course Title	Ornamental fish culture and Management					
Type of Course	**Major** Core					
Semester	IV					
Academic Level	200-299					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	3	-	2	75	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course delves into the ornamental fish industry, emphasizing the biology, breeding, culture, and management of ornamental fish. It addresses system design, water quality, nutrition, health, breeding methods, and marketing. The aim is to provide students with the skills and knowledge needed for successful ornamental fish management, focusing on sustainability and conservation.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Identify major ornamental fish species and their ecological requirements, and understand the significance of biodiversity."	R.U	F	Oral exams, Quizzes
CO2	Explain the setup and management of aquarium systems, emphasizing the selection of equipment and species compatibility.	U	C	Assignments, Quizzes
CO3	Apply techniques for maintaining water quality and health management practices in ornamental fish culture	Ap	p	Practical Sessions, Reports
CO4	Analyze breeding strategies and genetic selection principles to enhance ornamental fish production.	An	C	Case Studies Presentations
CO5	Evaluate market trends, regulatory impacts, and sustainability practices within the ornamental fish industry.	E	C	Group Project, Presentations
CO6	Create a conservation breeding program for endangered ornamental fish species that incorporates sustainable practices.	C	M	Project Report, Oral Exam
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)				

Metacognitive Knowledge (M)			
Module	**Unit**		**Hrs**
I	**Introduction to Ornamental Fish Culture**		**10**
	1	Overview of the ornamental fish industry	2
	2	Importance of ornamental fish in aquaculture	3
	3	Major ornamental fish species and their ecological needs	3
	4	Introduction to aquarium and aquarium accessories	2
II	**Aquarium Management**		**10**
	5	Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes	3
	6	Cleaning the aquarium; maintenance of water quality. Control of snail and algal growth	2
	7	Handling, care and transportation of fish. Temperature acclimation, oxygen packing.	2
	8	Design and operation of recirculating aquaculture systems (RAS)	3
III	**Commercial Production of Ornamental Fish: Strategies and Management**		**15**
	9	Species of ornamental fishes; their taxonomy and biology- Live bearers, Gold fish and koi, Gourami, Barbs and Tetras, angel fish, cichlids	2
	10	Maturation, secondary sexual characters, breeding habits, spawning, parental care. Larval rearing	2
	11	Commercial production of goldfish, live bearers, gouramies, barbs and tetras, angel fish	2
	12	Indigenous ornamental fishes of Kerala major species, distribution,	2
	13	Seed production of Miss Kerala.	2
	14	Important freshwater plants – their taxonomy and morphology, multiplication of aquarium plants	2
	15	Mass production of aquarium plants.	1
	16	Nutritional requirements of ornamental fish	1
	17	Types of feeds and feeding strategies	1
IV	**Marketing , sustainable practices and Conservation**		**10**
	18	Market trends and consumer preferences	2
	19	Export and import regulations	2
	20	Environmental impacts of ornamental fish culture	2
	21	Conservation breeding programs	2
	22	Regulatory frameworks and certifications	2
V	**Practical Applications in Aquaculture (Practical Module)**		**30**
	1	Identification of Commercially important ornamental species Design and construction of a beginner's aquarium Hands-on training on pH, ammonia, nitrite, and nitrate testing. Prepare and administer various types of feeds (live, frozen, pellets). Hands-on breeding session for selected species. Practice netting and handling fish with minimal stress Packaging techniques for transportation. Identification of aquarium plants	25
	2	Visit to a commercial ornamental fish farm or trade centre	5

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	2	-	1	3	2	1	-	2	-	1
CO 2	2	3	1	1	2	-	2	3	-	2	1	-	2
CO 3	3	1	2	3	-	3	3	3	2	3	-	3	1
CO 4	3	-	3	2	1	-	2	2	3	1	3	2	3
CO 5	=	1	2	3	3	2	1	2	-	2	3	1	2
CO 6	3	-	1	3	2	1	3	3	2	3	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔		✔
CO 3	✔		✔	✔
CO 4		✔	✔	✔
CO 5		✔		✔
CO 6	✔			✔

Suggested reading

1. "Ornamental Fishes and Aquatic Invertebrates: Self-Assessment Color Review" by Gregory A. Lewbart
2. "Handbook of Fish Biology and Fisheries, Volume 2: Fisheries" edited by Paul J.B. Hart and John D. Reynolds
3. "Ornamental Fish Farming: Breeding Styles in Groups of Ornamental Fish" by Brian Andrews
4. "Genetic Management of Hatchery Stocks" by Robert G. Danzmann and Aquaculture Genetics Research Group
5. Diseases of Ornamental Fishes: Diagnosis and Treatment" by Gerald Bassleer
6. The Ornamental Fish Trade: An Introduction with Perspectives for Responsible Aquarium Fish Ownership" by Eduard Nijman
7. Aquarium Success" by Peter Hiscock

Programme	B. Sc. Aquaculture Honours
Course Title	Aquaculture Nutrition and Feed Technology
Type of Course	**Major** Core
Semester	IV
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The Aquaculture Nutrition and Feed Technology course focuses on diet formulation, feed production, and sustainable practices in aquaculture, blending theory with practical application to enhance fish health and environmental sustainability.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the principles and significance of nutrition in aquaculture.	U	C	Quizzes, Lectures, Group Discussions
CO2	Analyze nutritional requirements and formulate diets for various aquaculture species.	An	p	Diet Formulation Assignments, Case Studies
CO3	Evaluate the impact of different feed ingredients and additives on fish health and growth.	E	C	Comparative Analysis Reports, Practical Demonstrations
CO4	Apply knowledge of feed manufacturing technology and quality control in feed production.	Ap	P	Factory Visits, Quality Assurance Simulations
CO5	Evaluate the sustainability and environmental impacts of aquafeed production practices."	E	C	Research Projects, Sustainability Assessments
CO6	Apply practical skills in implementing aquaculture feeding strategies."	Ap	P	Field Studies, Hands-On Workshops

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Aquaculture nutrition**		**10**
	1	Overview of aquaculture nutrition	2
	2	Digestive Physiology in Aquatic Species	3
	3	Nutrient Classification and Function:	3
	4	Nutritional Disorders in Aquaculture	2
II	**Feed Ingredients and Formulation**		**10**
	5	Types of Feed Ingredients	3
	6	Diet Formulation for Different Species/Finfishes/Shellfishes/Ornamental fishes	3
	7	Alternative and Novel Ingredients in Aquaculture Feeds	2
	8	Feed Additives and Functional Feed Ingredients	2
III	**Feed Manufacturing Technology**		**15**
	9	Principles of Feed Formulation	2
	10	Feed Production Techniques	2
	11	Feed Processing and Storage	1
	12	Environmental Impacts of Feed Production	1
	13	Feed Quality Control and Assurance	2
	14	Sustainable Feed Production Practices	2
	15	Nutritional Genomics and Aquaculture Feed Development	2
	16	Functional Feeds and Nutraceuticals in Aquaculture	2
	17	Emerging Trends in Aquaculture Feed Technology	1
IV	**Feeding Strategies and Management**		**10**
	18	Feeding Methods in Aquaculture	2
	19	Feeding Schedules and Rations	2
	20	Feed Conversion and Efficiency	2
	21	Impact of Feed on Water Quality and Ecosystem	2
	22	Precision Feeding and Nutritional Management	2
V		**Practical module**	**30**
		• Determination of the proximate composition (moisture, protein, fat, fiber, ash) of various feed ingredients. • Preparation of Pelleted feed. • Preparation of fish feed form naturally available ingredients • Assessment of the quality of aquaculture feeds through physical and chemical analysis. • Visit to Feed manufacturing unit	

Note: .The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four module

CO-PSO/PO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	2	-	2	2	1	-	2	3	-	1
CO 2	3	3	-	2	1	2	3	2	3	2	2	1	2
CO 3	2	-	-	3	-	3	3	3	2	1	3	2	3
CO 4	3	1	1	2	-	3	2	3	2	3	1	3	2
CO 5	2	2	1	3	-	-	3	2	3	-	3	2	3
CO 6	3	2	2	3	1	-	3	3	1	2	2	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination **Mapping of COs to Assessment Rubrics:**

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	-	-	-
CO 2	-	✓	-	-
CO 3	-	-	✓	-
CO 4	-	-	-	✓
CO 5	✓	-	✓	-
CO 6	-	✓	-	✓

Suggested reading

1. Fish Nutrition" by John E. Halver and Ronald W. Hardy
2. "Aquaculture Nutrition: Gut Health, Probiotics, and Prebiotics" by Daniel L. Merrifield and Einar Ringø
3. "Feed and Feeding Practices in Aquaculture" by D. Allen Davis
4. Aquafeed Formulation" by Sergio F. Nates
5. Alternative Protein Sources in Aquaculture Diets" edited by Chhorn Lim, Cheng-Sheng Lee, and Patricia J. O'Bryen
6. "Nutritional Biotechnology in the Feed and Food Industries: Proceedings of Alltech's Annual Symposium" edited by T.P. Lyons and K.A. Jacques

Programme	B. Sc. Aquaculture Honours					
Course Title	Freshwater & Brackish water aquaculture					
Type of Course	**Major** core					
Semester	IV					
Academic Level	200-299					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	3	-	2	75	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course on "Brackish water and Freshwater Aquaculture" teaches essential aquaculture techniques, sustainability, and farm management through theoretical lessons and practical experiences, preparing students for careers in the aquaculture industry.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the fundamentals of aquaculture, including the basic principles of freshwater and brackish water aquaculture systems, species selection, and their significance	U	C	Written exams, quizzes
CO2	Apply knowledge of water quality management and system design in both freshwater and brackish water settings.	Ap	P	Lab reports, practical exams
CO3	Analyze and implement culture techniques for key aquaculture species, including carps, tilapia, catfish, *Macrobrachium rosenbergii*, and brackish water species	An	P	Fieldwork reports, practical exams
CO4	Evaluate and apply sustainable aquaculture practices with a focus on disease management, environmental impact mitigation, and the integration of innovative systems like biofloc technology and IMTA	E	C	Case studies, project reports
CO5	Understand the economic aspects of aquaculture, including production costs, market dynamics, and the economic viability of aquaculture systems.	U	C	Written exams, presentations
CO6	Apply practical skills in aquaculture	Ap	P	Lab practicals,

	operations such as water quality testing, species identification, and farm management through hands-on experience and field visits."			field trips
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Basics of Freshwater Aquaculture**		**10**
	1	Introduction to Freshwater Aquaculture	2
	2	Types of Freshwater Aquaculture Systems and species selection	2
	3	Water Quality Management	3
	4	Pond preparation and fertilization, harvesting and Postharvest Management	3
II	**Production Techniques and Management in Freshwater Aquaculture**		**10**
	5	Culture of Major Freshwater Fishes Detailed study on the culture techniques of carps, tilapia, and catfish	3
	6	Freshwater pearl culture – Present status of freshwater pearl culture and production in India.	3
	7	Culture of *Macrobrachium rosenbergii*,	2
	8	Sewage fed fish culture, sewage treatment– Sewage cum fish culture in India	2
III	**Brackish water aquaculture Management and practices**		**15**
	9	Overview of Brackish Water Aquaculture	2
	10	Brackish Water Aquaculture Systems and Species Selection	1
	11	Pond Preparation and System Design for Brackish Water Aquaculture	1
	12	Harvesting Techniques and Post-Harvest Management in Brackish Water Aquaculture	2
	13	Sustainable Practices and Disease Management	2
	14	Techniques for culturing milkfish, mullet, and other brackish water finfish	2
	15	Culture of Mud Crab (Scylla spp.)	2
	16	Detailed study on the culture techniques for species such as *Penaeus monodon and Litopenaeus vannamei.*	2
	17	Aquaculture Economics	1
IV	**Advanced Topics in Brackish Water Aquaculture**		**10**
	18	Biofloc Technology in Brackish water aquaculture	2
	19	Principles and practices of IMTA, examples of successful IMTA systems in brackish waters	2
	20	Assessing and mitigating the environmental impacts of brackish water aquaculture practices	2
	21	Brackish water aquaculture and Farm tourism	2
	22	Brackish water aquaculture and Ecotourism	2
V	**Practical Applications in Aquaculture (Practical Module)**		**30**
	1	• Determination of basic water quality parameters such as pH,	20

		temperature, dissolved oxygen, ammonia, nitrites, and nitrates using water quality test kits • Identify and count the different types of algae present in water samples. • Determination of the feed conversion ratio (FCR) for a specific fish species. • Soil and Sediment analysis Analyze soil or sediment samples from aquaculture pond sites for texture, pH, and nutrient content. • Determination of microbial load in water samples from aquaculture systems. • Determination of rate of oxygen production by photosynthesis and consumption by respiration in an aquaculture system.	
	2	• Collection and Identification of Cultivable Species of Fishes • Visit to Fresh water and Brackish water aquaculture farms	10

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	-	-	2	1	-	2	3	2	1
CO 2	3	3	-	2	-	2	3	3	2	3	2	3	2
CO 3	3	2	2	-	-	-	3	3	3	2	1	3	3
CO 4	2	3	3	3	-	3	3	3	2	3	3	3	3
CO 5	-	2	-	-	2	2	2	2	-	1	3	2	1
CO 6	3	3	3	3	3	3	3	3	3	3	2	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	-	-	✔	✔
CO 2	✔	-	✔	✔
CO 3	✔	✔	-	✔
CO 4	-	✔	✔	✔
CO 5	✔	✔	-	✔
CO 6	✔	✔	✔	✔

<u>Suggested Reading</u>

1. Freshwater Aquaculture by Rath, A.K.
2. A Manual of Freshwater Aquaculture by Santhanam, et al.
3. Aquaculture: Principles and Practices by Pillay, T.V.R.
4. Fish and Fisheries of India by Jhingran, V.G.
5. Coldwater Fisheries of India by Jhingran, V.G. and Sehgal, K.L.
6. Aquaculture by Bardach, Rhyther, and Mc Larney
7. Textbook of Aquaculture by Huet, M.
8. Integrated Agriculture and Aquafarming Farming System by Rogen, Pallin, and Shehadeh
9. Water Quality in Warmwater Fish Ponds by Boyd, C.E.
10. Fishes: An Introduction to Ichthyology by Moyle, P.B. and Cech, J.J.
11. Aquaculture: Principles and Practices by Pillay, T.V.R.

V^{th} Semester Major Core Courses

Programme	B. Sc. Aquaculture Honours					
Course Title	Mariculture					
Type of Course	**Major** Core					
Semester	V					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4		0	60	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology. Should have completed previous semesters					
Course Summary	The course provides an in-depth exploration of Mariculture, focusing on the cultivation of finfish and shellfish, sustainable practices, and environmental management, preparing students to address and mitigate the ecological impacts associated with marine farming.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Describe the fundamentals, significance, and differences between mariculture, aquaculture, and traditional fishing.	Remember	Factual	Quizzes, Oral Examinations
CO2	Explain the types of mariculture systems and the technologies used, including their advantages and limitations.	Understand	Conceptual	Written Examinations, Assignments
CO3	Apply principles of biology and ecology to select and manage species for mariculture, incorporating system design and management practices.	Apply	Procedural	Practical Work, Lab Reports
CO4	Analyze the impact of mariculture on the environment and propose sustainable practices to mitigate negative effects.	Analyze	Conceptual	Case Study Analysis, Group Discussions
CO5	Evaluate the criteria for selecting species for mariculture based on economic, environmental, and biological factors.	Evaluate	Conceptual	Project Presentations, Peer Reviews
CO6	Design a mariculture project that integrates best practices for	Create	Procedural	Project Design, Final Project

	species selection, system design, and environmental sustainability.			Reports
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Principles of Mariculture**		**10**
	1	Overview of Mariculture: Definition, History, and Importance	2
	2	Comparison between Mariculture, Aquaculture, and Traditional Fishing	3
	3	Basic Biological and Ecological Principles of Marine Farming	3
	4	Present status of mariculture	2
II	**Mariculture Systems and Technologies**		**10**
	5	Types of Mariculture Systems: Cages, Ponds, Recirculating Systems, and Offshore Structures	3
	6	Introduction to Mariculture Equipment and Technology	3
	7	Innovations and Sustainable Practices in Mariculture	2
	8	Criteria for Selecting Species for Mariculture: Economic, Environmental, and Biological Considerations	2
III	**Culture of Fin fishes**		**20**
	9	Overview of Finfish Species in Mariculture sea breams, rabbitfish, Groupers, pomfret, yellowtail, cobia, flatfishes, tuna, cod, puffers, silver pompono and porgy	3
	10	Biological and Ecological Needs of Cultured Finfish	2
	11	Open Ocean Cages and Pens: Design, Operation, and Management	2
	12	Land-based Recirculating Aquaculture Systems (RAS)	2
	13	Integrated Multi-Trophic Aquaculture (IMTA) for Sustainable Finfish Culture	2
	14	Broodstock Management and Genetic Improvement Programs	2
	15	Larval Rearing Techniques and Nursery Management	2
	16	Health Management in Finfish Culture	2
	17	Vaccination and Health Monitoring Practices	3
IV	**Culture of Shell Fishes**		**8**
	18	Overview of Shellfish Species in Mariculture. (mussels, edible oysters, pearl oysters, clams, cockles, abalones, sea cucumber, squid, cray fish)	2
	19	Suspension Culture: Rafts, Longlines, and Buoys	2
	20	Bottom Culture: Trenches and Trays	2
	21	Hatchery and Nursery Techniques for Shellfish	1
	22	Selective Breeding and Spat Collection	1
V	**Open ended Module**		**12**
	1	Assessing the Environmental Impact of Mariculture: Eutrophication, Habitat Destruction, and Escapes	
	2	Strategies for Minimizing Environmental Impact and Enhancing Sustainability	
	3	Case Studies: Success Stories and Challenges in Species Cultivation	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	CO1	2	1	-	-	1	3	2	1	-	-	-	-
CO 2	CO2	3	2	1	-	2	2	3	2	-	-	-	-
CO 3	CO3	3	3	2	2	2	1	2	3	-	-	-	-
CO 4	CO4	2	2	3	3	1	-	-	-	3	2	1	-
CO 5	CO5	2	2	1	2	3	-	-	-	2	3	2	-
CO 6	CO6	3	3	2	3	3	-	-	-	1	2	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	–	✓	✓
CO 2	✓	✓	–	✓
CO 3	✓	✓	–	–
CO 4	✓	✓	–	✓
CO 5	✓	✓	–	✓
CO 6	✓	✓	–	–

Suggested reading

1. "Marine Aquaculture: Opportunities for Growth" by the National Research Council
2. Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C. Southgate
3. Seaweed Ecology and Physiology" by Catriona L. Hurd, Paul J. Harrison, Kai Bischof, and Christopher S. Lobban
4. Marine Shrimp Culture: Principles and Practices" by John A. Hargreaves and Craig L. Browdy
5. Advances in Aquaculture Hatchery Technology" edited by Geoff Allan and Gavin Burnell
6. "Recirculating Aquaculture Systems (RAS) in Marine Aquaculture" by Michael B. Timmons and James M. Ebeling
7. Ecological Aquaculture: The Evolution of the Blue Revolution" by Barry Costa-Pierc

Programme	B. Sc. Aquaculture					
Course Title	Fishing Techniques and Practices					
Type of Course	**Major** Core					
Semester	V					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	3	-	2	75	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course delves into fishing methods, gear, marine environment understanding, and sustainability, complemented by practical training on gear use and sustainable practices.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the fundamental principles and historical development of fishing methods and gear, including the marine environment's role and the principles of responsible fisheries.	U	C	Written exams, quizzes
CO2	Explain the characteristics and functionalities of different types of fishing crafts in India, highlighting the distinctions between traditional, motorized, and mechanized crafts.	R	F	Oral presentations, short quizzes
CO3	Analyze the classification, design, and operational mechanisms of both modern and traditional fishing gears, focusing on active and passive gear types.	An	P	Case studies, written analysis
CO4	Evaluate materials and technologies used in fishing craft and gear construction, including an assessment of sustainability and efficiency in modern boat building and netting materials.	E	P	Project reports, presentations
CO5	Apply knowledge of fishing gears, devices, and materials in practical	Ap	p	Field trips, practical exams

	settings, including the identification of synthetic and natural fibers, and the use of fish detection devices.			
CO6	Create and implement sustainable fishing gear technologies through hands-on workshops and on-board fishing excursions, demonstrating innovation in net making and gear repair.	C	P	Practical workshops, reflective journals
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction,**		**10**
	1	Principle and evolution of fishing methods and gear..	2
	2	Introduction to Marine environment	3
	3	Responsible fisheries,.	3
	4	CCRF, Safety at sea	2
II	**Fishing Crafts**		**10**
	5	Different types of fishing crafts in India- inland and marine ,traditional, motorized and mechanized.	3
	6	Trawlers	2
	7	Purse seiners	2
	8	Gill netters, long liners, trollers, deep sea vessels.	3
III	**Fishing Gears and Fish finding devices**		**15**
	9	Classification and description of modern fishing gears.	2
	10	Active Gears Design and operation of – trawls, purse seines, ring seines	2
	11	Design and operation of –beach / shore seine, boat seine, pole and line	2
	12	Passive Gears Design and operation of- gill nets, long lines, hooks, traps, stake net, dol net, chinese dip nets, cast nets	2
	13	Destructive fishing methods like electrical fishing, poisoning and use of dynamits	1
	14	Prohibited fishing practices	1
	15	Introductory information on echo-sounder, sonar, net sonde, global position systems, remote sensing, potential fishing zones	2
	16	Code of conduct of responsible fishing	2
	17	Turtle Exclusion Devices (TED) andBy-catch Reduction Devices (BRD).	1
IV	**Fishing Craft and Gear materials**		**10**
	18	Fishing craft materials – traditional and modern.	2
	19	Introduction to boat building materials - wood, steel, FRP, ferro-cement, aluminum etc	2
	20	Introduction to netting materials - natural and synthetic fishing gear materials	2

	21	Yarn numbering systems	2
	22	Fishing accessories	2
V		**Practical Module**	**30**
		Identification of traditional fishing gears Different types of hooks Identification of fishing accessories Identification of synthetic and natural fibres Artificial and live baits Identification of modern gears Fish detection devices - On board visit.	20
		On-Board Fishing Excursions Sustainable Fishing Gear Technology Net Making and Repair Workshops:	10

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	3	1	-	2	2	1	3	2	-	-	1
CO 2	1	2	-	2	3	1	3	2	-	1	-	2	2
CO 3	3	2	1	3	2	-	2	3	2	3	1	1	3
CO 4	2	3	3	1	2	3	1	2	3	2	3	2	2
CO 5	3	1	2	3	1	2	3	3	1	3	2	3	-
CO 6	2	3	3	2	3	1	3	2	2	3	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔		✔
CO 3	✔	✔	✔	✔
CO 4		✔	✔	✔
CO 5	✔	✔	✔	✔
CO 6		✔		✔

Suggested reading

1. Fish Catching Methods of the World" by A. von Brandt
2. Marine Fisheries Ecology" by Simon Jennings, Michel J. Kaiser, and John D. Reynols
3. "Introduction to the Practice of Fishery Science" by William F. Royce
4. "Gear Technology in Aquatic Environments" edited by Gui D. Jackson and Geoff A. Domeier
5. Sustainable Fishing Practices and Gear" by Pedro Barros and Lucía Campos-Domínguez
6. "FAO Training Series: Responsible Fish Capture Techniques" by the Food and Agriculture Organization
7. The Complete Book of Fishing Knots, Leaders, and Lines" by Lindsey Philpott

Programme	B. Sc. Aquaculture Honours					
Course Title	Fish Processing Technology					
Type of Course	**Major** Core					
Semester	V					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course on Fish Processing and Value Addition offers in-depth knowledge of preservation techniques and value addition in seafood, combining theoretical insights with practical experience to enhance industry standards and economic value.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the principles of fish preservation, including the importance of hygiene and sanitation in fish handling.	Understand (U)	Conceptual Knowledge (C)	Written exams, quizzes
CO2	Apply techniques for chilling, icing, drying, smoking, and freeze-drying fish, along with modern preservation methods.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, lab reports
CO3	Analyze the processes involved in freezing and canning fish, focusing on the underlying principles and various stages.	Analyze (An)	Procedural Knowledge (P)	Case studies, practical exams
CO4	Create high-quality fish fillets, value-added products, and by-products to enhance product quality and market value.	Create (C)	Procedural Knowledge (P)	Project work, presentations
CO5	Evaluate the economic impact and sustainability of utilizing fish processing by-products and adding value to seafood products.	Evaluate (E)	Metacognitive Knowledge (M)	Seminar presentations, research papers

CO6	Apply hands-on skills in processing, analyzing, and creating value-added seafood products through practical modules and field visits.	Apply (Ap)	Procedural Knowledge (P)	Field reports, project documentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to fish processing**		**10**
	1	Principles of fish preservation.	2
	2	Importance of hygiene and sanitation in fish handling.	3
	3	Quality of water and ice in fish handling and processing.	3
	4	Chilling and Icing	2
II	**Drying, Smoking and Freeze-drying**		**10**
	5	Principles of smoking, drying and salting of fish.	3
	6	Different types of drying and factors affecting drying Packing and storage of dried products	3
	7	Modern methods of preservation by irradiation and modified atmospheric storage	2
	8	Accelerated freeze drying and packing of freeze dried products.	2
III	**Freezing and Canning**		**15**
	9	Fundamental principles involved in freezing of fish and fishery products.	2
	10	Various freezing methods	1
	11	Freezing of shrimps and fishes..	1
	12	Preparation of fish fillets	2
	13	Changes during the cold storage of fish and fishery products.	2
	14	Principles involved in canning of fish	2
	15	Different stages of canning of Tuna	2
	16	Retortable pouch processing	1
	17	Cut open test , commercial sterility and F value	2
IV	**Value Addition and By-Products**		**10**
	18	Value addition in sea food.	2
	19	Value added products , Advantages of value addition	2
	20	Battered and breaded products. Preparation of products viz. fish/prawn pickle, fish wafers, fish soup powder,	2
	21	By products and its economic significance	2
	22	Fish meal, fish protein concentrate, shark fin rays, fish maws, isinglass, fish liver oil, fish body oil, fish hydrolysates, chitin, chitosan, glucosamine hydrochloride, squalene, pearl essence, ambergris, gelatin, beche-de-mer, fish silage	2
V		**(Practical Module)**	**30**
	1	1.Determination of moisture content in fish and fishery products 2.General description – freezing	20

		3.Processing shrimp 4.Filleting of fish 5.Organoleptic analysis of fish 6.Preparation of fishery by products 7.Preparation/identification of shark fin rays fish maws, chitin, fish wafer 8.Fish pickling 9.Value added fishery products, fish curry, cutlets fish finger. 10.Collection of fishery by-products	
	3	Field visit 1.Visit to sea food pre-processing plants 2.Visit to fish processing plants Institutional Visit: 1.CIFT, 2.NIFPHATT	10

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	-	1	-	1	1	3	2	1	2	3	2	-
CO 2	3	3	2	2	2	1	3	3	2	3	2	2	1
CO 3	3	2	1	3	3	2	3	2	-	3	3	3	2
CO 4	3	3	3	2	3	3	3	3	3	2	3	3	3
CO 5	2	2	2	3	3	3	2	2	2	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examinati

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔	✔	✔
CO 3	✔	✔		✔
CO 4	✔	✔	✔	✔
CO 5		✔	✔	✔
CO 6	✔	✔	✔	✔

Suggested reading

1. Fish Processing Technology by K. Gopakumar, ICAR, New Delhi
2. Fish Processing Technology by T.K. Govindan, Oxford & IBH Publication Co.
3. Fish Canning: Principles & Practices by K.K. Balachandran
4. Fish as Food by Borgstrom, G.
5. Postharvest Technology in Fish and Fishery Products by K.K. Balachandran
6. Fish Processing in India by Moorjani, M.V.
7. Advances in Fishery Science and Technology by Connell, J.J.
8. Manual of Quality Control in Fish and Fishery Products by CIFT
9. Fish Packaging Technology by Gopakumar, K.

V^{th} SemesterMajor Elective courses

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquaponics and integrated farming Systems					
Type of Course	**Major** Elective					
Semester	V					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course provides a comprehensive overview of aquaponics and integrated farming systems, exploring the symbiotic relationship between aquatic animals and plants, system designs, water quality management, and sustainable farming practices. It prepares students for innovative agriculture practices by covering various integrated systems, sustainability, market dynamics, and includes practical applications through case studies and farm visits.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the basic concepts and designs of aquaponics and integrated farming systems, including the symbiotic relationships between plants and aquatic animals.	(U)	(C)	Written exams, quizzes
CO2	Apply techniques for managing water quality, nutrient dynamics, and the selection of appropriate fish and plant species in aquaponics systems.	(Ap)	(P)	Practical exams, lab reports
CO3	Analyze the sustainability, benefits, and challenges of various integrated farming practices such as Duck-Fish, Fish-Rice, and Fish-Vegetable cultures.	(An)	(C)	Case studies analysis, presentations
CO4	Create and manage integrated farming systems, utilizing ecosystem management, pest and	(C)	(P)	Project work, design assignments

	disease control strategies, and resource optimization for productivity and sustainability.			
CO5	Evaluate the economic aspects, market dynamics, and the role of emerging technologies in aquaponics and integrated farming, and their contributions to global food security and sustainability.	(E)	(C)	Seminar presentations, research papers
CO6	Apply practical skills in aquaponics and integrated farming through engagement with case studies, farm visits, and project work, promoting innovation and entrepreneurial thinking.	(Ap)	(P)	Field reports, project documentation
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**An introduction to Aquaponics**		**10**
	1	Fundamentals of aquapoincs Aquaponics System components, and cycle.	2
	2	Understanding symbiotic relationships between plants and aquatic animals.	3
	3	Underlying principles and Process involved	3
	4	Learning about different types of aquaponics systems (media-filled beds, NFT, DWC) and their components	2
II			**10**
	5	Water Quality Management: Understanding key water quality parameters, testing, and maintenance.	3
	6	Fish in Aquaponics: Selection criteria, care, and management of fish suitable for aquaponics systems.	3
	7	Plants in Aquaponics: Selection of compatible plant species and their cultivation in aquaponics.	2
	8	Nutrient Dynamics: Study of nutrient cycles, supplementation, and management in aquaponics systems.	2
III	**Overview of Integrated Farming:**		**20**
	9	Integrated farming and Types of Integrated Farming Practices an overview	3
	10	Fish-Duck Culture	2
	11	Fish-Rice Culture	2
	12	Fish-Vegetable Culture	2

	13	Fish-Pig Culture:	2
	14	Fish-Cattle Culture:	2
	15	Fish -Seaweed culture	2
	16	Fish – Mushroom Culture	2
	17	Integrated Crop-Livestock-Fish Systems	3
IV		**Sustainability and Market dynamics**	**8**
	18	Sustainability in Integrated Farming:	2
	19	Economics of Integrated Farming:	2
	20	Benefits and Challenges:	2
	21	Emerging Technologies:	1
	22	Market Linkages: Connecting farmers with markets, value addition.	1
V		**Open Ended Module: Case studies and Practical Applications**	**12**
	1	Global and Local Case Studies Success stories of integrated farming systems.	
	2	Designing an Integrated Farm: Practical project on planning and implementing a small-scale integrated farm	
	3	Visit to integrated farms	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	1	-	-	3	2	-	2	3	1	-
CO 2	3	3	2	2	1	1	3	-	3	3	2	2	1
CO 3	2	3	3	2	2	2	2	3	3	1	3	2	2
CO 4	3	3	3	3	3	3	3	3	2	2	3	3	3
CO 5	2	2	2	3	3	2	2	2	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔	✔	✔
CO 3		✔		✔
CO 4	✔	✔		✔
CO 5		✔	✔	✔
CO 6	✔	✔	✔	✔

Suggested reading

1. "Aquaponic Gardening: A Step-by-Step Guide to Raising Vegetables and Fish Together" by Sylvia Bernstein
2. "The Aquaponic Farmer: A Complete Guide to Building and Operating a Commercial Aquaponic System" by Adrian Southern and Whelm King
3. Recirculating Aquaculture Systems (RAS)" by Michael B. Timmons and James M. Ebeling
4. Aquaponics Food Production Systems: Combined Aquaculture and Hydroponic Production Technologies for the Future" edited by Simon Goddek et al.
5. Integrated Aquaculture**:** Combining Fish and Plant Farming" by R.K. Reddy
6. **"**Permaculture for Aquaculture: Landscaping & Aquaponics" by David Wright
7. **"**Integrated Farming Systems" by R.K. Singh and B. Chakraborty
8. Introduction to Integrated Farming Systems" by D. Rajasekaran

Programme	B. Sc. Aquaculture Honours
Course Title	Climate change and Aquatic resources
Type of Course	**Major** Elective
Semester	V
Academic Level	300-399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The "Climate Change and Aquatic Resources" course provides an in-depth exploration of the impacts of climate change on marine and freshwater ecosystems, emphasizing the challenges and opportunities it presents for sustainable aquaculture practices. Through a blend of theoretical knowledge and practical application, students will learn to assess vulnerabilities, devise adaptation strategies, and contribute to the resilience of aquatic resources in the face of global climate change.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the basic science of climate change, its global effects, and the importance of communication and public awareness.	(U)	(C)	Written exams, quizzes
CO2	Analyze the impact of climate change on marine and freshwater ecosystems, including ocean acidification and deoxygenation.	(An)	(C)	Case studies, project reports
CO3	Evaluate the vulnerability of aquaculture to climate change and identify sustainable adaptation and mitigation practices.	(E)	(P)	Research papers, presentations
CO4	Apply traditional knowledge and technological innovations to enhance climate resilience in aquaculture practices.	(Ap)	(P)	Practical exams, lab reports
CO5	Evaluate policies and governance frameworks to	(E)	(C)	Group discussions,

	enhance climate resilience in aquaculture at both international and national levels			policy analysis projects
CO6	Apply field-based learning to observe and assess the application of climate-smart aquaculture practices in real-world settings	Ap	(P)	Field trip reports, reflective journals
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Fundamentals of Climate Change**		**10**
	1	Introduction to Climate Change: Overview, causes, and global effects.	2
	2	Climate Change Science: Understanding greenhouse gases, carbon cycles, and climate modelling	3
	3	Impact of Climate Change on Global Weather Patterns: Changes in temperature, precipitation, and extreme weather events	3
	4	Climate Change Communication and Public Awareness	2
II	**Climate Change and Aquatic Ecosystem**		**10**
	5	Effects on Marine Ecosystems: Ocean acidification, sea temperature rise, and impacts on coral reefs.	3
	6	Effects on Freshwater Ecosystems: Changes in river flows, lake temperatures, and ice cover	3
	7	Biodiversity Loss and Species Migration: Consequences for aquatic food webs and species distribution	2
	8	Ocean Deoxygenation and Its Effects	2
III	**Climate Change Impacts on Aquaculture and Mitigation practices**		**20**
	9	Vulnerability of Aquaculture to Climate Change: Risk assessment and management. .	3
	10	Adaptation Strategies for Aquaculture: Breeding, feed management, and disease control	2
	11	Climate-Induced Changes in Aquatic Pathogens and Disease Dynamics	2
	12	Reducing carbon footprint in aquaculture operations.	2
	13	Integrated Multi-Trophic Aquaculture (IMTA), recirculating aquaculture systems (RAS).	2
	14	Ecosystem-based Aquaculture Management: Conservation and restoration of aquatic habitats	2
	15	Carbon Sequestration in Aquatic Environments: Blue carbon ecosystems	2
	16	Water Use Efficiency and Management: Techniques for reducing water footprint.	2
	17	Policy and Governance for Climate-Resilient Aquaculture: International	3

		agreements and national strategies	
IV	**Climate Resilience in Indian Aquaculture**		**8**
	18	Impact of Monsoon Variability on Aquaculture:	2
	19	Mangrove Ecosystems as Natural Defenders	2
	20	Traditional Knowledge and Adaptation Strategies	2
	21	Technological Innovations for Climate-Smart Aquaculture	2
	22	Policy Framework for Climate-Adaptive Aquaculture in India	2
V	**Open-Ended Module**		**12**
	1	Global Case Studies	
	2	Research Trends in Aquaculture and Climate Change:	
	3	Field Trips	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	2	-	1	3	2	1	2	3	2	-
CO 2	3	3	2	2	2	1	3	3	2	2	2	2	1
CO 3	3	2	1	3	3	2	3	2	-	3	3	3	2
CO 4	3	3	3	2	3	3	3	3	3	2	3	3	3
CO 5	2	2	2	3	3	3	2	2	2	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, internal exam, End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔	✔	✔
CO 3	✔	✔		✔
CO 4	✔	✔	✔	✔
CO 5		✔	✔	✔
CO 6	✔	✔	✔	✔

Suggested reading

1. 1."Climate Change and Marine and Freshwater Toxins" edited by Luis M. Botana, M. Carmen Louzao, and Natalia Vilariño
2. "Climate Change Impacts on Fisheries and Aquaculture: A Global Analysis" edited by Bruce F. Phillips and Mónica Pérez-Ramírez
3. "Aquatic Ecosystems in a Changing Climate" by Wayne C. Huber
4. "Marine Ecosystems and Global Change" edited by Manuel Barange, John G. Field, Roger P. Harris, Eileen E. Hofmann, R. Ian Perry, and Francisco Werner
5. "Adapting to a Changing Environment: Confronting the Consequences of Climate Change" by Tim R. McClanahan and Joshua E. Cinner
6. "Climate Change and the Oceanic Carbon Cycle: Variables and Consequences" edited by Apple Academic Press

Programme		B. Sc. Aquaculture Honours
Course Title		Blue Economy and Aquaculture
Type of Course		**Major** Elective
Semester		V
Academic Level		300-399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours	Exam Duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course provides an in-depth exploration of the Blue Economy, focusing on sustainable use of ocean resources and the economic opportunities it offers, alongside environmental sustainability and marine conservation.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the concept, principles, and key sectors of the Blue Economy.	(U)	(C)	Written exams, quizzes
CO2	Understand the significance of ecosystem services and natural capital in the context of the Blue Economy.	(U)	(C)	Written exams, group discussions
CO3	Analyze the linkage between Sustainable Development Goals (SDGs) and the Blue Economy.	(An)	(C)	Research papers, presentations
CO4	Evaluate sustainable practices in fisheries, aquaculture, and marine bioprospecting for the Blue Economy.	(E)	(P)	Case studies, practical exams
CO5	Evaluate the distinctions between the Green and Blue Economies, and analyze environmental sustainability challenges associated with the Blue	(E)	(C)	Written exams, debates

	Economy.			
CO6	Analyze innovative sectors within the Blue Economy, such as green shipping, marine renewable energy, and sustainable tourism.	(An)	(C)	Project work, field trips
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Blue Economy**		**10**
	1	What is Blue economy	2
	2	Principles of blue economy	2
	3	Coastal and Ocean industries	3
	4	Blue economy Stake holders and innovators	3
II	**Ecosystem Services**		**10**
	5	Introduction to Ecosystem services	3
	6	Natural capital and the blue economy	3
	7	Valuing ecosystem services,	2
	8	The fundamental techniques used to value natural resources and ecosystem services	2
III	**Sustainable Development and Blue economy**		**20**
	9	Sustainable Development Goals (SDGs) and the Blue Economy: Understanding the linkage	3
	10	Marine Biodiversity: Importance for the blue economy.	2
	11	Sustainable Fisheries and Aquaculture: Practices and technologies.	2
	12	Marine Bioprospecting: Potential for new products and medicines	2
	13	Aquaculture's Role in the Blue Economy: How aquaculture contributes to sustainable ocean resource use.	2
	14	Blue economy prospects and opportunities	2
	15	Difference between Green and Blue Economy.	2
	16	Environmental Sustainability of the Blue Economy.	2
	17	Blue Economy and Marine Pollution Issues.	3
IV	**Exploring the Blue Economy**		**8**
	18	Green Shipping and Port Management:	2
	19	Marine Renewable Energy	2
	20	Sustainable Marine Tourism	2
	21	Ocean Health and Wildlife:	1
	22	Marine Conservation Strategies	1
V	**Open ended Module**		**12**
	1	Aquaculture tourism and blue economy	
	2	Marine waste management	
	3	International Maritime Law: UNCLOS and other agreements.	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	2	-	1	3	2	1	2	3	2	-
CO 2	3	3	2	2	2	1	3	3	2	2	2	2	1
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CO 4	3	3	3	2	3	3	3	3	3	2	3	3	3
CO 5	2	2	2	3	3	3	2	2	2	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔	✔	✔
CO 3	✔	✔		✔
CO 4	✔	✔	✔	✔
CO 5		✔	✔	✔
CO 6	✔	✔	✔	✔

Suggested reading

1. "The Blue Economy: 10 Years, 100 Innovations, 100 Million Jobs" by Gunter Pauli
2. "Blue Economy: Promise, Practice and Prospects" by Rajib Shaw, A. N. M. Fakhruddin, and Indrajit Pa
3. "Valuing Ecosystem Services: Toward Better Environmental Decision-Making" by the National Research Council
4. "Sustainable Development Goals and the Blue Economy" by the United Nations
5. Marine Biodiversity and the Blue Economy" in "Marine Policy" journal –
6. Green Shipping Practices: From Traditional Techniques to Emerging Technologies" in "Marine Pollution Bulletin"
7. Ocean Innovation: Biomimetics Beneath the Waves" by Iain A. Anderson, and Julian Vincent
8. "International Law and the Protection of the Marine Environment" by Howard S. Schiffman -

Programme	B. Sc. Aquaculture Honours					
Course Title	Fish Biochemistry					
Type of Course	**Major** Elective					
Semester	V					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course delves into the biochemical constituents of aquatic life, covering the intricate biochemistry of proteins, lipids, and enzymes found in fish, crustaceans, and molluscs. It explores their structural, functional, and post-mortem changes, alongside the preparation and properties of marine polysaccharides, emphasizing the practical applications and impacts of these biochemical processes on seafood quality and nutrition.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the biochemical constituents of fish, crustaceans, and mollusks, including their proteins and lipids.	Understand	Conceptual	Written exams, quizzes
CO2	Analyze the structural and functional properties of seafood proteins and lipids, understanding their importance in nutrition and food processing.	Analyse	Conceptual	Practical exams, lab reports
CO3	Evaluate the impact of post-mortem biochemical changes and processing methods on the quality of seafood.	Evaluate	Conceptual	Case studies, project reports
CO4	Apply knowledge of enzymatic reactions, including kinetics and mechanisms, to assess seafood quality and shelf-life.	Apply	Procedural	Lab practicals, presentations

CO5	Investigate the roles of polysaccharides in seafood, focusing on the preparation and applications of chitin, chitosan, and glucosamine.	Analyze	Procedural	Research projects, lab exercises
CO6	Synthesize knowledge of antioxidants, oxidation indices, and enzyme classifications to develop strategies for preserving seafood quality.	Create	Procedural	Group projects, seminar presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Biochemical composition of fish**		**10**
	1	Biochemical constituents of fish, crustaceans and mollusks.	2
	2	Biochemistry of fish proteins, Classification. Sarcoplasmic proteins, Myofibrillar proteins and Stroma proteins	3
	3	Structure of fish muscles and Post mortem biochemical changes, rigor mortis	3
	4	Non-protein nitrogenous compounds, K value	2
II	**Proteins**		**10**
	5	Functional properties of seafood proteins: Solubility, emulsification, viscosity, water holding, stability, gelation,	3
	6	Precipitation of proteins, Salting in and Salting out	3
	7	Denaturation and coagulation of proteins	2
	8	Changes in proteins during processing	2
III	**Seafood Lipids**		**20**
	9	Seafood lipids: Composition and nutritive value	3
	10	Triglycerides, phospholipids,	2
	11	Non-saponifiables including sterols and vitamins.	2
	12	Classification and naming of fatty acids	2
	13	MUFA, PUFA, HUFA , Omega 3 Fatty acids	2
	14	Auto-oxidation of fatty acids, rancidity	2
	15	Lipasas and phospholipases, ,	2
	16	Pro- and anti-oxidants,	2
	17	Oxidation indices, Peroxide value , TBA Value, FFA value	3
IV	**Enzymes**		**8**
	18	Structure and function of enzymes	2
	19	Kinetics of enzyme activity, KM value, Turnover number,	2
	20	Mechanism of Enzyme activity	2
	21	Classification of enzymes,	1
	22	Ribozymes, Abzymes, Synthetic enzymes	1

V	**Open ended Module- Polysaccharides**		**12**
	1	Polysaccharides Naming and Classification	
	2	Hetero polysaccharides, commercial importance	
	3	Preparation of Chitin, Chitosan, and Glucosamine	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	1	2	2	1	2	2	2	1	2
CO 2	3	2	2	2	1	3	3	1	2	2	3	2	2
CO 3	2	2	1	3	1	3	2	1	2	2	3	2	3
CO 4	2	1	2	2	2	3	2	1	3	3	2	1	2
CO 5	2	2	3	2	2	2	2	1	2	2	3	2	3
CO 6	3	2	3	3	2	3	3	2	3	2	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓		✓
CO 6	✓	✓	✓	✓

Suggested reading

1. Fish Biochemistry" by D.E. Vance and J.E. Vance
2. Biochemistry and Molecular Biology of Fishes" edited by Patrick W. Hochachka and T.P. Mommsen
3. "Fish Nutrition" by John E. Halver and Ronald W. Hardy
4. ."Aquaculture Nutrition: Gut Health, Probiotics, and Prebiotics" by Daniel Merrifield and Einar Ringø
5. K. Gopakumar - Fish Processing Technology, ICAR, New Delhi
6. Connell, J.J. - Advances in Fishery science and Technology.

VI th Semester Major Core courses

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquaculture Engineering and Technology					
Type of Course	**Major** Core					
Semester	VI					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course on Aquaculture Engineering and Technology provides an in-depth exploration of the engineering principles behind aquaculture systems, including farm design, equipment, production systems, and the latest technologies for sustainable aquaculture practices. It combines theoretical knowledge with practical applications, including visits to aquaculture farms, to prepare students for advanced roles in the aquaculture industry, focusing on innovation, efficiency, and biosecurity.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the foundational principles of aquaculture engineering, including site selection criteria and surveying techniques essential for aquaculture system design.	(U)	(C)	Written exams, quizzes
CO2	Apply knowledge in the design and management of diverse aquaculture systems such as Recirculating Aquaculture Systems (RAS), cage, and pond cultures, with an emphasis on maintaining water quality and optimizing system components.	(Ap)	(P)	Practical exams, project work
CO3	Apply principles of farm design, focusing on the integration and optimization of equipment, aeration systems, and pumps to enhance aquaculture operations.	(Ap)	(P)	Design assignments, presentations
CO4	Analyze and implement advanced techniques in broodstock management, hatchery design, and operation, ensuring efficient use of hatchery equipment.	(An)	(P)	Case studies, lab reports

CO5	Create and integrate automation and biosecurity measures into aquaculture practices to improve operational efficiency and disease prevention.	(C)	(P)	Design projects, seminar presentations
CO6	Evaluate recent innovations in aquaculture technology through case studies and practical experiences, aiming to encourage continuous improvement and innovation in the field.	(E)	(M)	Field reports, group discussions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Farm Engineering.**		**10**
	1	Principles of Aquaculture Engineering:	2
	2	Criteria for the selection of site for aquaculture – freshwater, brackishwater and marine aquaculture	2
	3	Surveying –Chain survey, plane table survey, leveling	3
	4	Calculation of earthwork for the construction of ponds. Types of soil, soil sampling methods, prevention of erosion	3
II	**Farm Design and Equipment**		**10**
	5	Design of freshwater and brackish water farms. Project formulation and layout.. Various farm equipment..	3
	6	Different components of aquafarms – peripheral dikes, secondary dikes, feeder canals, sluice gate and monks	3
	7	Role of aeration in culture ponds. Paddle wheel aerators aspirators, compressors and blowers	2
	8	Pumps in aquaculture, different type of pumps	2
III	**Aquaculture Production Systems**		**20**
	9	Recirculating Aquaculture Systems (RAS): Design and operation of RAS.	3
	10	Water Treatment Technologies: Filtration, aeration, and disinfection methods.	2
	11	Cage Culture Engineering: Design and management of cage culture systems	2
	12	Pond Culture Engineering: Construction and management of pond systems	2
	13	Raceway Systems: Design, flow control, and management.	2
	14	Broodstock Management Technologies	2
	15	Components of shrimp hatcheries – various components and infrastructure facilities required.	2

	16	Various hatchery equipment including aeration devices and pumps. Mechanical and biological filters	2
	17	Hatchery Design and Operation: Systems design, larval rearing, and nursery techniques.	3
IV	**Automation and Biosecurity**		**8**
	18	Automation in Aquaculture	2
	19	Automated feeding systems and feed management.	2
	20	Sensors and Instrumentation: Applications in water quality and fish behavior monitoring	2
	21	Biosecurity in Aquaculture	1
	22	Design and implementation of biosecurity plans.	1
V	**Open Ended Module**		**12**
	1	Innovations in Aquaculture Technology	
	2	Case Studies and Application	
	3	Visit to Aquaculture farms	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	2	-	-	3	2	-	3	3	1	-
CO 2	3	3	2	3	2	1	3	3	2	3	3	2	2
CO 3	2	2	3	2	1	2	2	2	3	2	2	2	1
CO 4	3	3	2	3	3	2	3	2	-	3	3	3	3
CO 5	2	2	3	3	2	3	2	3	2	2	2	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✔		✔	✔
CO 2	✔	✔	✔	✔
CO 3	✔	✔		✔
CO 4	✔	✔	✔	✔
CO 5		✔	✔	✔
CO 6	✔	✔	✔	✔

<u>Suggested reading</u>

1. "Aquaculture Engineering" by Odd-Ivar Lekang
2. "Biofloc Technology - A Practical Guidebook" by Yoram Avnimelech
3. "Recirculating Aquaculture" by Michael B. Timmons and James M. Ebeling
4. "Design and Operating Guide for Aquaculture Seawater Systems" by J. Colt
5. Coastal Aquaculture Engineering by Bose et. al. -
6. Aquaculture Engineering by Wheaton F W

Programme	B. Sc. Aquaculture Honours					
Course Title	Biostatistics and Bioinformatics					
Type of Course	**Major** core					
Semester	VI					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	5	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course provides a comprehensive foundation in bioinformatics and biostatistics tailored for aquaculture, covering essential statistical concepts, bioinformatics tools, and their application in aquaculture research. Through hands-on practical exercises, students will learn to analyze genetic data, understand disease mechanisms, and apply sustainable practices to enhance aquaculture productivity and sustainability.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Undrstand fundamental statistical concepts including methods of data collection, sampling methods, and measures of central tendency such as arithmetic mean, median, and mode.	Understand (U)	Conceptual (C)	Quizzes, Written Exams
CO2	Apply descriptive statistical techniques to analyze aquaculture data, including the calculation of range, mean deviation, standard deviation, and understanding their application in aquaculture research.	Apply (Ap)	Procedural (P)	Practical Assignments, Lab Reports
CO3	Analyze aquaculture datasets for skewness, kurtosis, and perform regression and correlation analysis to determine	Analyze (An)	Procedural (P)	Case Studies, Analysis Reports

	relationships between variables.			
CO4	Understand the role of bioinformatics in aquaculture, familiarize with primary bioinformatics databases, and use tools for sequence alignment and phylogenetic analysis.	Understand (U)	Conceptual (C)	Quizzes, Database Navigation Exercises
CO5	Apply bioinformatics tools and techniques for genetic diversity studies, disease-associated gene identification, and analysis of quantitative traits in aquaculture species.	Apply (Ap)	Procedural (P)	Project Work, Practical Sessions
CO6	Apply practical skills in using bioinformatics and statistical software for data analysis and visualization, including sequence alignment, protein structure visualization, and statistical analysis of aquaculture data.	Apply (Ap)	Procedural (P)	Lab Exercises, Software Tool Usage Reports
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Basic Statistics**		**10**
	1	Methods of data collection and Sampling methods	2
	2	Tbulation and diagrammatic representation of data	3
	3	Arithmetic mean, median, mode	3
	4	Geometric mean and harmonic mean.	2
II	**Statistical Analysis**		**10**
	5	Range, mean deviation, - calculation and its application.	3
	6	Standard deviation and coefficient of deviation	2
	7	Skewness and kurtosis.	2
	8	Regression and Correlation	3
III	**Introduction to Bioinformatics**		**15**
	9	Overview of bioinformatics and its significance in aquaculture.	2
	10	Basic concepts of molecular biology and genetics.	2
	11	Introduction to primary databases (GenBank, EMBL, DDBJ).	2
	12	Overview of protein and genome databases.	2
	13	Principles of sequence alignment.	1
	14	Tools for sequence alignment (BLAST, ClustalW).	1

	15	Introduction to phylogenetic analysis.	2
	16	Building phylogenetic trees and their applications in aquaculture.	2
	17	Basics of genomics and proteomics.	1
IV	**Applications of Bioinformatics in Aquaculture**		**10**
	18	Utilizing molecular markers for genetic diversity studies and population structure analysis in aquaculture species	2
	19	Strategies for applying molecular markers in selective breeding programs for improved traits.	2
	20	Techniques for identifying and analyzing disease-associated genes in aquaculture species.	2
	21	Bioinformatics tools and techniques for analyzing quantitative traits linked to growth, yield, and disease resistance.	2
	22	Exploration of novel bioinformatics approaches and technologies shaping the future of sustainable aquacultur	2
V	**Practical Module**		**30**
		1. Calculate the mean, median, and mode of a given data set 2. Drawing(manually or using a basic software tool like Microsoft Excel) and Interpreting a Bar Graph of given data 3. Preparation Pi chart using any basic data collection either manually or using a basic software tool like Microsoft Excel 4. Preparation and interpretation of Scatter plot either manually or using Microsoft excel 5. Preparation and interpretation of line graoh either manually or using Microsoft excel 6. Calculation of Standard deviation of given dataset	15
		1. Learn to navigate and search for gene and protein information using NCBI and UniProt databases. 2. Use online tools like BLAST to perform simple sequence alignments and understand the output. 3. Retrieve and explore a GenBank entry, learning about its different components like the description, features, and sequence 4. Use an online tool to translate a DNA sequence into its corresponding protein sequence and understand the concept of codons 5. Introduction to the Protein Data Bank (PDB) and using tools like RCSB PDB or PyMOL to visualize protein structures. 6. Introduction to phylogenetics and using simple online tools to create a phylogenetic tree from provided sequences	15

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	-	2	1	-	2	1	-	1	2	-	1
CO 2	3	2	-	3	2	3	3	2	1	2	3	3	2
CO 3	3	3	2	3	3	3	3	-	2	3	2	3	3
CO 4	-	3	3	-	2	-	-	3	-	-	-	-	-
CO 5	3	3	3	3	3	3	3	3	2	3	3	3	3
CO 6	3	-	-	3	-	3	3	-	2	3	3	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3		✓	✓	✓

CO 4	✓		✓	
CO 5	✓	✓		✓
CO 6		✓	✓	✓

Suggested reading

1. ."Biostatistics: A Foundation for Analysis in the Health Sciences" by Wayne W. Daniel and Chad L. Cross
2. "Principles of Biostatistics" by Marcello Pagano and Kimberlee Gauvreau
3. Bioinformatics: Sequence and Genome Analysis" by David W. Mount
4. "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner
5. Biostatistics and Computer-based Analysis of Health Data using R" by Christophe Lalanne and Mounir Mesbah
6. Introduction to Bioinformatics" by Arthur M. Lesk
7. Statistical Bioinformatics: with R" by Sunil K. Mathur

Programme	B. Sc. Aquaculture Honours
Course Title	Fishery Microbiology and Quality control
Type of Course	**Major** Core
Semester	VI
Academic Level	300-399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	This course offers an in-depth exploration of microbiology with a focus on aquatic environments and aquaculture systems, integrating historical perspectives, microbial structure and function, and practical applications in seafood safety and microbial management. Through a combination of theoretical knowledge and practical skills, students will learn to isolate, characterize, and manage microorganisms critical to aquatic health, food safety, and quality control.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Evaluate the historical contributions of Louis Pasteur, Koch, and Winogradsky to microbiology and understand the characteristics of various microorganisms.	E & U	C & F	Written exams, oral presentations
CO2	Apply microscopy techniques to study the ultrastructure of prokaryotic and eukaryotic cells, including virus classification and life cycles.	Ap	P	Lab reports, practical exams
CO3	Analyze the microflora of aquatic environments using isolation and cultivation techniques to understand bacterial and fungal growth.	An	C & P	Case studies, research projects
CO4	Create strategies for microbial management in aquaculture ponds and understand biogeochemical cycles.	C	P & C	Project design, strategy proposals
CO5	Develop and implement quality control protocols for seafood safety,	Ap & C	P & C	Simulations, role-play exercises,

	including spoilage prevention and HACCP principles.			practical demonstrations
CO6	Conduct practical techniques for microbial isolation, enumeration, and characterization, and assess seafood quality.	Ap	P	Lab practicals, sensory evaluation exercises
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Foundations of Microbiology and Microbial Structure**		**10**
	1	History and Development of Microbiology: Contributions of Louis Pasteur, Koch, and Winogradsky	2
	2	General characteristics of bacteria, fungi, viruses, algae, and protozoans.	3
	3	Microbial Structure Biology: Principles and applications of various microscopy techniques	3
	4	Ultrastructure and function of prokaryotic and eukaryotic cells, including bacteria, fungi, yeast, and viruses. Classification of viruses, and the life cycle of bacteriophages	2
II	**Aquatic and Aquaculture Microbiology**		**10**
	5	Aquatic Microbiology: Microflora of aquatic environments, isolation, and cultivation techniques.	3
	6	Nutrition and growth of bacteria and fungi, prokaryotic growth characteristics, and the impact of environmental factors.	3
	7	Aquaculture Microbiology: Microbial dynamics in culture ponds, nutrient regeneration,	2
	8	Biogeochemical cycles and the significance of autotrophic and heterotrophic microorganisms.	2
III	**Sea food safety and Quality control**		**15**
	9	Perishability of seafood, spoilage microflora of fish and shellfish,	2
	10	Intrinsic and extrinsic factors affecting spoilage	1
	11	Health risks associated with filter feeding bivalve shellfish and their depuration	1
	12	Different types of spoilage in fishery products – chemical, physical and biological spoilage	2
	13	Quality control – basic concepts, Salient features of sea food quality.	2
	14	Risk factors in sea food- biotoxins, physical, chemical and biological hazards.	2
	15	HACCP, SSOP, GMP.	2
	16	Methods of evaluating fish freshness and quality – organoleptic, sensory, physical, chemical, microbiological and instrumental methods	2
	17	Sampling systems followed in processing plants for testing the quality	1
IV	**Isolation and Characterization of Aquatic Microorganisms**		**10**
	18	Isolation enumeration of bacteria from water, sediment and fish	2
	19	Isolation and cultural characteristics of *Vibrio sp*	2

	20	Isolation and cultural characteristics of *Salmonella sp*	2
	21	Isolation and cultural characteristics of *E.coli*	2
	22	Isolation and cultural characteristics of *Staphylococcus aureus*	2
V	**Practical module**		**30**
		1. Sterilization technique- dry heating, autoclaving 2. Media preparation 3. Isolation and maintenance of bacteria from fishes and water. 4. Gram staining of bacteria 5. Enumeration of bacteria by TPC method 6. Enumeration of total coli forms 7 Motility test 8 Antibiotic Sensitivity studies	15
		1 Estimation of Chlorine in Bleaching powder 2 Organoleptic analysis of given fish 3 Estimation free fatty acid value 4 Estimation of Peroxide value 5 Estimation of Total Volatile Base nitrogen	15
	3		

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	-	2	1	3	2	3	2	1	-	2	1	3
CO 2	3	-	1	2	2	3	3	2	3	-	1	2	2
CO 3	2	-	3	3	1	1	2	3	2	-	3	1	1
CO 4	1	-	2	3	2	3	3	1	3	-	2	2	3
CO 5	2	-	3	1	3	2	2	3	1	-	3	3	2
CO 6	3	-	1	2	2	1	1	3	2	-	2	3	1

Correlation Levels:

Level	Correlation
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓			✓
CO 2		✓		✓
CO 3	✓		✓	
CO 4		✓	✓	
CO 5			✓	✓
CO 6	✓	✓		

Suggested reading

1. Microbiology by Pelzar, Reid & Chan
2. Microbiology by Prescolt, Harley & Klein
3. Introduction to Microbial World by Adelogerg, Ingra & Wheates
4. Productivity in Aquatic Bodies by Anon.
5. Microbial Safety of Fishery Products by Chincheste, C.O. and Graham, H.D.
6. Principles of Sensory Evaluation of Foods by Amerine, M.A. and Pangborn, R.M.

VIth Semester Major Elective courses

Programme	B. Sc. Aquaculture Honours
Course Title	Aquatic Animal Health and Disease Management
Type of Course	**Major** Elective
Semester	VI
Academic Level	300-399

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	This course focuses on advanced aquaculture techniques, covering the comprehensive spectrum from breeding, nutrition, and health management to molecular diagnostics for aquatic animal health. It aims to equip students with in-depth knowledge of aquatic ecosystems, innovative aquaculture practices, sustainable and ethical management, along with business and quality control skills essential for the global seafood trade.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Evaluate the types and causes of various aquatic diseases, including protozoan, bacterial, and viral diseases, in fish and shrimp.	E	C & F	Written exams, oral presentations, critical review essays.
CO2	Understand the relationship between disease and environment in aquaculture, and apply this knowledge to mitigate environmental factors contributing to disease outbreaks.	U & Ap	C	Group discussions, written assignments, environmental analysis reports.
CO3	Apply diagnostic tools and techniques, such as microscopy, immune detection, and DNA/RNA techniques, for effective	Ap & An	P & C	Lab practicals, diagnostic test result analysis, presentation of

	disease identification in aquaculture.			findings.
CO4	Analyze the nutritional needs of aquatic organisms to prevent nutritional deficiencies and related diseases through effective management strategies.	An & E	C & P	Nutritional plan development, case study critiques, oral defenses.
CO5	Create vaccination and disease management strategies for aquatic organisms, incorporating the latest developments in vaccines and chemotherapeutics.	C & E	P & C	Project proposals, strategy design documents, peer-reviewed presentations.
CO6	Develop and implement sustainable aquaculture practices, including pond management and disease prevention, to enhance the health and productivity of aquatic organisms.	Ap & C	P & C	Project implementation reports, sustainability assessments, practical demonstrations.

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Introduction to Aquatic Diseases and Protozoan Diseases**		**10**
	1	Overview of fish diseases including pathology and parasitology..	2
	2	Definitions and categories of diseases, the relationship between disease and environment	2
	3	Detailed study of protozoan diseases affecting finfish, such as Ichthyophthiriasis, Costiasis, whirling diseases, and trypanosomiasis.	3
	4	Examination of shrimp protozoan diseases including Microsporidiosis, Gregaria disease, and ecto-commensal protozoan	3
II	**Fungal Diseases and Nutritional Pathology**		**10**
	5	Detailed coverage of fungal disease Saprolegniosis and Brachiomycosis,	3
	6	Fungal diseases such as Ichthyophorus diseases, Lagenidium diseases, and Fusarium diseas	2

	7	Comprehensive overview of nutritional pathology including lipid liver degeneration, deficiency diseases due to essential nutrients like vitamins (A, D, E, K, B-Complex, C), pantothenic acid, folic acid, biotin, choline, minerals,	3
	8	The impact of aflatoxin dinoflagellate Antibiotics and chemotherapentants.	2
III	**Bacterial and Viral Diseases**		**20**
	9	Bacterial diseases in finfish, furunculosis, columnaris,	3
	10	Bacterial gill disease, gill rot, Entero redmouts	2
	11	Edwardsiellosis, vibriosis, tail and fin rot, EUS.	2
	12	Exploration of shrimp bacterial diseases such as brown spot, black gill,	2
	13	Filamentous bacterial disease, and luminous vibriosis	2
	14	viral diseases in finfish and shrimp, including IPN, IHN, Viral Hemorrhagic Septicemia,	2
	15	Spring Viremia of carps, CCVD, Carp lymphocystis, Bacculovirus penaeii	2
	16	Monodon Bacculovirus, Bacculoviral midgut necrosis, IHHNV,.	2
	17	Hepatopancreatic parvo like virus, Yellow head bacculovirus, and white spot baculovirus	3
IV	**Immunology and Disease Management**		**8**
	18	Introduction to the immune defense mechanisms in fish and shellfish, application, and development of vaccines.	2
	19	Diagnostic tools for disease identification: microscopy, immune detection, and DNA/RNA techniques.	2
	20	Nutritional cataract, genetically and environmentally induced diseases.	2
	21	Principles of vaccine development for aquatic organisms,	1
	22	The Role of Antibiotics and Chemotherapeutics in Disease Control	1
V	**Open ended Module**		**12**
	1	Best practices for pond management to ensure eco-friendly and sustainable aquaculture, including quarantine procedures, good feed management, zero water exchange,	
	2	The use of probiotics in health management	
	3	Methods for the pathological examination of fish and infectious diseases, production of disease-free seeds, and evaluation criteria for healthy seeds.	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	2	2	1	3	3	2	1	1	3	2	2
CO 2	2	3	1	1	3	2	3	1	1	2	3	1	2
CO 3	1	2	3	3	2	1	2	1	3	3	2	1	3
CO 4	3	1	2	2	3	1	2	3	1	1	2	3	2
CO 5	2	3	1	1	2	3	1	3	2	2	1	3	1
CO 6	1	2	3	3	1	2	1	2	3	3	1	2	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, internal exam, End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓			✓
CO 2		✓		✓
CO 3	✓		✓	
CO 4		✓	✓	
CO 5			✓	✓
CO 6	✓	✓		

Suggested Reading

1. Fish Disease: Diagnosis and Treatment by Edward J. Noga

2. Encyclopedia of Fish Disease by R. Ramachandran Nair
3. Prevention and Control of Fish and Prawn Diseases by K.P. Biswas
4. Principle Diseases of Marine Fish and Shellfish by Sinderman, C.J.
5. Diseases and Disorders of Finfish in Cage Culture by Patrick T. K. Woo, David W. Bruno, and L. H. S. Lim
6. Aquaculture Pathophysiology edited by Frederick S. B. Kibenge and Mark D. Powell

Programme	B. Sc. Aquaculture Honours					
Course Title	Sustainable Aquaculture Practices					
Type of Course	**Major** Elective					
Semester	VI					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course delves into the complexities of aquatic ecosystems, highlighting sustainability, the challenges posed by climate change, and the economic and biological constraints on aquatic resource management. Through a blend of theoretical knowledge and practical application, it equips students with the skills to innovate in aquaculture, implement sustainable practices, and navigate the intricacies of green technologies in the field					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the role and impacts of aquatic ecosystems on food, nutrition, and livelihood systems.	U	C	Written exams, discussions
CO2	Analyze the ecological impacts of exotic species introduction, salinization, and mangrove deforestation.	An	C & F	Case studies, research papers
CO3	Evaluate the economic and environmental challenges in aquatic resource management including water and land use conflicts.	E	C	Essays, presentations
CO4	Apply principles of sustainable aquaculture development and understand biological constraints in aquaculture.	Ap	P & C	Project proposals, lab practicals

CO5	Create strategies for implementing advanced sustainable aquaculture practices and renewable energy applications.	C	P & C	Design projects, strategy development exercises
CO6	Analyze green technologies in aquaculture for water recycling, energy efficiency, and smart aquaculture technologies.	An	P & C	Analytical reports, technology assessment presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**"Aquatic Ecosystems: Sustainability, Threats, and Climate Change Impacts"**		**10**
	1	Role of aquatic resources in food and nutrition; Aquatic resource and livelihood systems.	2
	2	Exotic species introduction, escapement, contamination of indigenous gene pool,	2
	3	Salinization of soil and water, over exploitation of wild stocks, mangrove deforestation	3
	4	Impact of climate change	3
II	**Economic Challenges in Aquatic Resource Management**		**10**
	5	Water and Land Use Conflicts	3
	6	Aquaculture vs. Traditional Fishing: Navigating Interests	2
	7	Community Resistance to Aquatic Resource Projects	3
	8	International Trade and Environmental Policies	2
III	**Biological Constraints and Sustainable Practices in Aquaculture**		**20**
	9	Availability of Juveniles in Aquaculture	3
	10	Nutritional Requirements in Aquaculture	2
	11	Disease Management and Pathogen Control	2
	12	Principles of Sustainable Aquaculture Development	2
	13	Open vs. Closed Aquaculture Systems	2
	14	Water System Design Principles	2
	15	Coastal Aquaculture Guidelines	2
	16	FAO Code of Conduct for Responsible Fisheries	2
	17	Guidelines for Sustainable Aquaculture	3
IV	**Strategies for Sustainable Aquaculture**		**8**
	18	Foundations of Sustainability in Aquaculture	2
	19	Advanced Sustainable Aquaculture Practices- Rotational Aquaculture and	2

		Bioremediation, Biotechnology's Role	
	20	Renewable Energy Applications in Aquaculture	2
	21	Trade, Export, and Value Addition of Fishery Products	1
	22	Implementing Sustainable Aquaculture: Challenges and Future Directions	1
V	**Open ended Module Introduction to Green Technologies in Aquaculture**		**12**
	1	Water Recycling and Treatment Technologies	
	2	Energy Efficiency and Renewable Energy Solutions	
	3	Smart Aquaculture Technologies	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	1	2	-	-	3	2	1	-	2	3	1
CO 2	2	2	3	3	-	1	2	-	-	-	3	2	2
CO 3	1	2	-	3	3	2	2	1	3	-	2	3	1
CO 4	3	3	2	3	2	3	3	-	2	1	3	2	3
CO 5	3	2	3	3	3	3	3	-	2	2	3	3	3
CO 6	2	1	3	2	2	2	2	-	1	3	3	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, internal exam, End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓			✓
CO 2		✓		✓
CO 3	✓		✓	
CO 4		✓	✓	
CO 5			✓	✓
CO 6	✓	✓		

Suggested Reading

1. Beets, W.C. -Raising and Sustaining Productivity of Small-Holder Farming Systems in the Tropics.
2. Edwards, P & H. Demaine -Rural Aquaculture: Overview and Framework for Country
3. Edwards, P., D.C. Little & H. Demaine -Rural Aquaculture.
4. J. E. Bardach- Sustainable Aquaculture
5. James P&Mc Vey -Handbook of Mariculture Vol. I. Crustacean Aquaculture.
6. Bardach, Rhyther, & Mc. Larney- Aquaculture, Farming & Husbandry of freshwater & Marine Organisms
7. Pillay, T.V.R. & Dill, W.M.A- Advances in Aquaculture.
8. Pillay. T.V.R. & M.N. Kutty - Aquaculture: Principles and Practices.
9. Takeo Imai - Aquaculture in shallow seas.
10. Ayyappan, S- Handbook of Fisheries and Aquaculture

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquatic Ecology and Conservation in Aquaculture					
Type of Course	**Major** Elective					
Semester	VI					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed Previous semesters					
Course Summary	The course offers an in-depth exploration of aquatic ecosystems, focusing on biodiversity, ecological dynamics, conservation practices, and the application of modern technologies in fisheries management. It aims to equip students with the knowledge and skills necessary to address contemporary challenges in marine and freshwater environments, emphasizing sustainable practices and the protection of aquatic biodiversity.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the components, structure, and functions of aquatic ecosystems.	U	C	Written exams, quizzes
CO2	Analyze ecological concepts such as succession, homeostasis, natality, and mortality within ecosystems.	An	C	Case studies, project reports
CO3	Apply concepts of habitat, ecological niche, and carrying capacity to real-world scenarios.	Ap	C	Practical exams, fieldwork reports
CO4	Evaluate biodiversity and the impact of human activities on marine and freshwater environments.	E	C	Seminar presentations, research projects
CO5	Create strategies for the conservation of aquatic biodiversity and fisheries management.	C	P	Group projects, policy drafting exercises

CO6	Utilize modern computer tools for ecosystem modeling and understand the ecosystem approach to fisheries management.	Ap	P	Lab practicals, softwar
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**"Foundations of Aquatic Ecosystems**		**10**
	1	Aquatic ecosystem– components, structure and functions..	2
	2	Ecological concepts – succession, homeostasis, natality and mortality	3
	3	Concepts of habitat and ecological niche; carrying capacity	3
	4	Ecological classification of marine and freshwater	2
II	**Conservation and Biodiversity**		**10**
	5	Biodiversity and diversity indices.	3
	6	IUCN categorization and endangered fishes.	3
	7	Conservation of freshwater resources and fish	2
	8	Ecological importance of mangrove vegetation	2
III	**Marine Environments and Conservation Strategies**		**20**
	9	The division of the marine environment – benthic, pelagic, bathyal, littoral capacity.	3
	10	Ocean waters as a biological environment	2
	11	Distribution and population of plants and animals.	2
	12	Littoral Zones: Fauna of intertidal zones, their distribution and adaptations	2
	13	Effects of pollution on marine life	2
	14	Impact of climate change/global warming in marine fisheries.	2
	15	Management of reserves- in situ and ex situ conservation	2
	16	Aquatic Protected Areas. Marine sanctuaries	2
	17	Modern computer tools in ecosystem modeling and trophic interactions. ECOPATH and ECOSIM	3
IV	**Advanced Fisheries Management:**		**8**
	18	Ecosystem approach to Fisheries management	2
	19	Use of technology in fisheries conservation using TED,BRD etc.	2
	20	Use of selective fishing gears, mesh size regulations, capture of juveniles	2
	21	Deep sea fishing policy of India.	1
	22	KMFR Act	1
V	**Open Ended Module Regulatory Measures and International Agreements"**		**12**
	1	International fishery regulations, treaties and instruments.	
	2	Input control measures such as access control, size, type, number and power of boats, duration of fishing	
	3	Output control measures such as Total Allowable Catch. Catch Quotas, Licensing	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	2	2	1	2	3	2	2	3	3	2	2
CO 2	3	3	2	2	1	2	3	2	2	3	3	2	2
CO 3	2	2	3	3	2	2	2	3	2	2	2	3	3
CO 4	3	3	2	3	2	3	3	2	2	2	3	3	3
CO 5	2	2	3	3	3	3	2	3	3	2	2	3	3
CO 6	2	2	3	3	2	2	2	2	3	3	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2		✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓

CO 6	✓	✓	✓	✓

Suggested reading

1. "Freshwater Ecology: Concepts and Environmental Applications of Limnology" by Walter K. Dodds and Matt R. Whiles
2. "Marine Ecology: Processes, Systems, and Impacts" by Michel J. Kaiser et al.
3. "Ecology of Aquatic Systems" by Mike Dobson and Chris Frid
4. "Aquatic Ecosystems: Interactivity of Dissolved Organic Matter" edited by Stuart Findlay and Robert L. Sinsabaugh
5. "Aquatic Conservation: Marine and Freshwater Ecosystems" by John Wiley & Sons
6. "Conservation of Freshwater Fishes" edited by Gerard P. Closs, Martin Krkosek, and Julian D. Olden
7. "The Diversity of Fishes: Biology, Evolution, and Ecology" by Gene Helfman, Bruce B. Collette, Douglas E. Facey, and Brian W. Bowen
8. "Marine Protected Areas for Whales, Dolphins, and Porpoises: A World Handbook for Cetacean Habitat Conservation" by Erich Hoyt
9. "Restoration and Management of Lakes and Reservoirs" by G. Dennis Cooke, Eugene B. Welch, Spencer Peterson, and Stanley A. Nichols

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquaculture farm Management					
Type of Course	**Major Elective**					
Semester	VI					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The Aquaculture farm Management course is designed to equip students with comprehensive knowledge and practical skills necessary for the successful operation and management of aquaculture facilities. It covers a wide range of topics, from water quality and feed management to sustainable practices and business planning, preparing students for a career in the evolving aquaculture industry.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the scope and significance of the aquaculture industry and its various farming types.	U	C	Written exams, quizzes
CO2	Apply knowledge of water quality management and filtration systems in aquafarming.	Ap	P	Practical exams, lab reports
CO3	Evaluate and implement effective feed types and disease management strategies for optimal productivity.	E	P	Case studies, project reports
CO4	Analyze and utilize advanced aquaculture equipment and technology for farm efficiency.	An	P	Presentations, lab practicals
CO5	Create sustainable aquafarming practices,	C	C	Research projects, seminar presentations

	understanding environmental impacts and adhering to regulations.			
CO6	Develop a comprehensive business model for aquaculture ventures, including market analysis and financial planning.	C	P	Group projects, business plan submissio
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Aquaculture Fundamentals: Industry Overview and Water Management Techniques**		**10**
	1	Overview of aquaculture industry	2
	2	Types of aquafarms: freshwater, marine, and brackish water	3
	3	Parameters of water quality	3
	4	Systems for water filtration and circulation	2
II	**Optimizing Aquafarm Productivity: Nutrition, Health, and Technological Innovations**		**10**
	5	Feed types and feeding strategies	3
	6	Disease prevention and management	3
	7	Advances in aquaculture equipment	2
	8	Role of technology in modern aquafarms	2
III	**Comprehensive Aquaculture Management: From Hatchery to Harvest and Beyond**		**20**
	9	Principles of hatchery design and operation	3
	10	Broodstock management and spawning techniques	2
	11	Larval rearing conditions and methodologies	2
	12	Best practices for sustainable aquaculture	2
	13	Mitigating environmental impacts	2
	14	National and international regulations	2
	15	Certification and standards for sustainable aquaculture	2
	16	Business plan development	2
	17	Market analysis and marketing strategies	3
IV	**Advanced Aquaculture Systems**		**8**
	18	Concepts and benefits of IMTA systems	2
	19	Designing IMTA systems for sustainability and productivity	2
	20	Case studies of successful IMTA implementations	2
	21	Latest innovations in aquaculture technology	1
	22	The role of automation and remote monitoring in improving aquafarm efficiency	1
V	**Open ended Module Entrepreneurship and Business Management in Aquaculture**		**12**

	1	Entrepreneurial opportunities in the aquaculture industry	
	2	Developing a business model for aquaculture ventures	
	3	Financial planning, investment, and risk management in aquafarm businesses	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	1	2	2	1	2	2	1	1	2
CO 2	3	3	2	2	1	3	2	2	3	3	2	1	2
CO 3	3	2	3	3	2	3	3	2	3	2	3	2	3
CO 4	2	2	2	3	3	2	2	3	2	3	2	1	2
CO 5	3	3	3	3	2	3	3	2	3	2	3	3	3
CO 6	2	2	1	2	3	2	2	2	2	1	2	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4		✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓		✓	✓

Suggested reading

1. "Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C. Southgate
2. "Principles of Aquaculture" by Robert R. Stickney
3. "The Economics of Aquaculture with Respect to Fisheries" by Frank Asche and Trond Bjørndal
4. "Aquaculture Economics and Financing: Management and Analysis" by Carole R. Engle
5. "Sustainable Aquaculture" by Peter Edwards, David C. Little, and Harvey Demaine
6. "Recirculating Aquaculture Systems (RAS)" by Michael B. Timmons and James M. Ebeling
7. "Aquaculture Technology: Flowing Water and Static Water Fish Culture" by R. O. A. Moll

VIIth SemesterMajor Core Courses

Programme	B. Sc. Aquaculture Honours					
Course Title	Capture Fisheries					
Type of Course	**Major** core					
Semester	VII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course covers the economics, diversity, and management of capture fisheries, emphasizing the significance of marine fisheries in India, global fish production trends, and the conservation of pelagic and demersal species, alongside the management of India's crustacean and molluscan fisheries					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Gain a foundational understanding of the marine fisheries sector and its significance in the Indian economy and food security.	U	C	Written exams, quizzes
CO2	Analyze global and Indian inland and estuarine fisheries resources, including trends, production, and issues in fisheries development.	An	C	Project reports, case studies
CO3	Understand the impact of climate change on marine fisheries and adapt fisheries management practices accordingly.	Ap	C	Presentations, research projects
CO4	Identify the major fishing zones of the world and India, with a focus on pelagic and	U	C	Quizzes, written exams

	demersal fish species and their conservation.			
CO5	Evaluate the regulatory frameworks governing marine fisheries in India, including policies and acts, for sustainable fisheries management.	E	P	Seminar presentations, case studies
CO6	Apply knowledge of crustacean and molluscan fisheries management, emphasizing sustainable practices and conservation.	Ap	P	Practical exams, lab reports
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	**Unit**		**Hrs**
I	**Introduction to Capture fisheries**		**10**
	1	Marine fisheries sector, its significance in the Indian economy, and its role in food security	2
	2	Major inland waters of the world and India, their fish fauna; global inland fish production trends; major inland fish producing countries and ecosystems.	3
	3	Estuarine fisheries resources of India, Fisheries of major estuarine systems in India and Kerala. Fishing methods, recent statistics of catches, problems encountered in fisheries development of major estuaries	3
	4	Examination of the regulatory framework governing marine fisheries in India, including the Marine Fishing Regulation Acts (MFRA) of various states.	2
II	**Contemporary Issues and Trends in Global Marine Fisheries**		**10**
	5	Global marine fish production trends	3
	6	FAO status, Deep sea fishing policy of India	3
	7	Impact of climate change	2
	8	Major fishing zones of world and India	2
III	**Pelagic Fisheries: Diversity, Production, and Conservation**		**20**
	9	Introduction to pelagic fishery resources,	3
	10	White baits, Anchovies,	2
	11	Shads and other clupeids,	2
	12	Tuna, Seer fish	2
	13	Carangids, Ribbonfish,	2
	14	Barracudas, Bombay ducks	2
	15	Pomfrets, and mullet	2

	16	Sardines, Mackerels,	2
	17	Features and trends in the production of pelagic fisheries, Conservation of pelagic fish stock	3
IV	**"Demersal Fisheries: Species, Management, and Sustainability**		**8**
	18	Perches, Threadfinbreams, , ,	2
	19	Groupers, Snappers	2
	20	Bull's eye, Flat fishes	2
	21	Sciaenids, eels	1
	22	Features and trends in production of demersal fisheries. Conservation of demersal fish stock	1
V	**Open Ended Module Crustacean and Molluscan Fisheries in India: Exploitation and Management"**		**12**
	1	Crustacean Fishery of India: Penaeid and non-penaeid shrimp fisheries.	
	2	Lobster fishery, Crab fishery.	
	3	Molluscan fishery of India: Mussel fishery, Oyster fishery, Clam fishery Cephalopod fishery,Gastropod fishery	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	1	1	2	3	2	2	1	1	2	1
CO 2	3	2	3	2	1	3	2	3	2	2	1	3	2
CO 3	3	3	2	3	2	2	3	2	3	3	2	2	3
CO 4	2	2	2	2	2	1	2	2	2	2	2	2	2
CO 5	1	3	3	1	3	3	1	3	3	2	3	1	3
CO 6	2	2	2	3	2	2	2	2	3	3	2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4	✓	✓		✓
CO 5		✓	✓	✓
CO 6	✓		✓	✓

<u>Suggested reading</u>

1. "Marine Fisheries Ecology" by Simon Jennings, Michel J. Kaiser, and John D. Reynolds
2. "Inland Fisheries: Ecology and Management" by Robin Welcomme
3. "The Indian Fisheries Sector: Challenges and Opportunities" by A. P. Sharma
4. "Fisheries of the World" by Sudipta Kumar De
5. "Conservation of Fish and Shellfish Resources: Managing Diversity" by Gene S. Helfman
6. "Marine Policy & Economics: A Derivative of the Encyclopedia of Ocean Sciences" by John H. Steele, Steve A. Thorpe, and Karl K. Turekian
7. "Pelagic Fish: The Resource and its Exploitation" by Peter J.B. Hart and John D. Reynolds
8. "Demersal Fishery Resources and Management in Southeast Asia" by T. E. Chua and D. Pauly

Programme	B. Sc. Aquaculture Honours					
Course Title	Instrumentation					
Type of Course	**Major** core					
Semester	VII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course on Instrumentation delves into the comprehensive understanding and application of modern instrumentation, including spectrophotometry, chromatography, electrophoresis, and microscopy, tailored to the needs of the aquaculture industry. It emphasizes hands-on experience with instrument calibration, data analysis, and the integration of various analytical methods for enhancing productivity, sustainability, and innovation in seafood production and aquafarm management					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Gain comprehensive understanding of advanced analytical techniques and their applications in aquafarm management.	U	C	Written exams, quizzes
CO2	Apply instrument calibration, validation principles, and ensure laboratory safety and maintenance.	Ap	P	Practical exams, lab reports
CO3	Master quantitative analysis techniques through spectrophotometry, including operation and analysis.	Ap	P	Lab practicals, project reports
CO4	Analyze and interpret data from chromatography and electrophoresis for substance identification and quantification.	An	P	Practical exams, research projects
CO5	Utilize advanced microscopy techniques for detailed examination and analysis of aquaculture samples.	Ap	P	Lab practicals, presentations
CO6	Conduct field visits to reputed laboratories to observe real-world applications of analytical techniques in aquaculture.	Ap	F	Field reports, group projects

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Overview of Instrumentation in Science**		**10**
	1	Introduction to advanced analytical techniques, their importance, and applications	2
	2	Overview of integrating multiple instruments for comprehensive analysis.	3
	3	Instrument Calibration and Validation	3
	4	Safety and Maintenance of Laboratory Instruments	2
II	**Fundamentals of Spectrophotometry**		**10**
	5	Principles of Spectrophotometry	3
	6	Types of Spectrophotometers UV-Visible, Infrared (IR), and Atomic Absorption (AAS) spectrophotometers, and their specific applications.	3
	7	Quantitative Analysis Techniques -	2
	8	Troubleshooting and Best Practices	2
III	**Chromatography and Electrophoresis**		**15**
	9	Foundations of Chromatography:	1
	10	Types of Chromatography:	1
	11	Gas Chromatography	2
	12	High-Performance Liquid Chromatography	2
	13	Advanced Chromatographic Technique	2
	14	Principles of Electrophoresis	2
	15	Agarose Gel Electrophoresis,	2
	16	Polyacrylamide Gel Electrophoresis	2
	17	Capillary Electrophoresis (CE) and Advanced Techniques	1
IV	**Microscopy**		**10**
	18	Overview of Microscopy	2
	19	Bright field Microscopy and Fluorescence Microscopy	2
	20	Dark field microscopy	2
	21	Phase Contrast and Differential Interference Contrast (DIC) Microscopy	2
	22	Electron microscopy TEM, SEM	2
V	**Practical Module**		**30**
	1	Laboratory Safety and Instrument Handling Practical Spectrophotometry Spectrophotometer Operation Quantitative Analysis Exercises Chromatography Techniques GC and HPLC Operation: Sample Preparation and Analysis: Electrophoresis Agarose and Polyacrylamide Gel Preparation Visualization and Interpretation: Advanced Microscopy Techniques	20

		Microscope Setup and Imaging Sample Preparation for Electron Microscopy	
	2	Visit to Reputed laboratories	10

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	2	3	1	2	3	2	3	1	2	2	3
CO 2	2	3	3	2	2	1	2	3	2	3	1	3	2
CO 3	3	2	1	3	3	2	3	2	3	2	2	2	3
CO 4	2	3	2	1	2	3	3	2	1	3	3	2	2
CO 5	3	1	2	2	3	2	2	3	2	3	2	1	3
CO 6	2	2	3	1	2	3	1	2	2	2	3	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6		✓	✓	✓

Suggested reading

1. Instrumentation in biology by Ajibade, V., & Ajenifuja,
2. . (2019). Introduction to instrumentation of life sciences.by Sharma, S

   Biochromatography by Vijayalakshmi, M. A. (2020).. CRC Press.
3. Practical protein chromatography: Methods in molecular biology (Vol. 11). By Kenney, A., & Fowell, S.
4. Ultraviolet-visible spectrophotometry in pharmaceutical analysis by Gorog, S.
5. Scanning transmission electron microscopy b Bruma, CRC Press.
6. Gel electrophoresis -Novel approaches by Jill Clark

Programme	B. Sc. Aquaculture Honours					
Course Title	Live feed Culture					
Type of Course	**Major** core					
Semester	VII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course on live feed in aquaculture dives deep into the science and techniques behind the cultivation, enrichment, and preservation of live feeds essential for aquaculture operations. Covering topics from natural food sources to advanced culture systems, students will learn to optimize nutrition and enhance the sustainability and productivity of aquaculture practices.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the importance of natural food and its enrichment and preservation in aquaculture.	U	C	Written exams, quizzes
CO2	Apply techniques for the enrichment and preservation of live feeds, including Artemia and microalgae.	Ap	P	Lab reports, practical exams
CO3	Analyze the nutritional quality of commonly used fish food organisms and the role of periphyton in aquaculture.	An	C	Case studies, project reports
CO4	Master the production and use of Artemia, including cyst hatching, morphology, and nutritional quality.	Ap	P	Practical exams, lab practicals
CO5	Cultivate microalgae and zooplankton, understanding culture conditions, harvesting techniques, and nutritional value.	Ap	P	Hands-on workshops, presentations
CO6	Evaluate the efficiency of live feed production systems and develop strategies for optimizing aquaculture	E	C	Research projects, group projects

	nutrition.			
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Natural food**		**10**
	1	Natural food and its importance in aquaculture. Enrichment and preservation of live feeds.	2
	2	Nutritional quality of commonly used fish food organisms	3
	3	Enrichment and preservation of live feeds.	3
	4	Use of periphyton in aquaculture	2
II	**Artemia culture**		**10**
	5	Artemia: Morphology, strains,: morphology, harvesting, nutritional quality, enrichment and preseration	3
	6	Biology, life cycle and ecology of artemia.	2
	7	Use of cysts; disinfection procedure, decapsulation; hatching.Nauplii and metanauplii	2
	8	Production and use of grown artemia; pond production; harvesting and processing techniques	3
III	**Microalgal culture**		**15**
	9	Microalgal Culture: Uses of microalgae in aquaculture.	1
	10	Culture media. Harvesting and preservation of microalgae	1
	11	Major classes and genera of cultured algal species	2
	12	Algal mass culture techniques.	2
	13	Algal production in outdoor ponds.	2
	14	Nutritional value of microalgae. Bacterioplankton as live feed	2
	15	Algal production; physical and chemical conditions; growth dynamics;	2
	16	Isolation and maintenance of stock cultures	2
	17	Quantifying algal biomass	1
IV	**Zooplankton Culture**		**10**
	18	Zooplankton culture: Morphology, biology,.Nutritional value of cultured zooplanktons.	2
	19	Life cycle and general culture conditions of live feed organisms; Rotifers, Cladocerans and Copepods	2
	20	Zooplankton mass culture techniques	2
	21	Production and use of resting eggs of rotifers and cladocerans	2
	22	Culture of nematods. Mesocosm systems for live feed production	2
V	**Practical Module**		**30**
	1	1. Demonstration of live feed enrichment techniques 2. Preservation methods for live feeds. 3. Setting up periphyton substrates in aquaculture systems 4. Artemia cyst hatching experiment to observe life stages. 5. Techniques for harvesting, enriching, and preserving Artemia. 6. Preparation of algal culture media. 7. Hands-on microalgal culture techniques, including batch and continuous	20

		cultures. 8. Setting up cultures of rotifers, cladocerans, and copepods. 9. Observing life cycles and morphological characteristics.	
	2	Visit to Hatcheies	10

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	2	3	2	3	2	1	2	1	3
CO 2	2	3	2	3	1	2	3	2	3	2	1	2	2
CO 3	1	2	3	1	3	2	2	1	2	3	3	2	1
CO 4	3	1	2	3	2	1	3	2	1	2	3	1	3
CO 5	2	3	1	2	3	2	2	3	2	1	2	3	2
CO 6	2	1	3	2	2	3	1	2	3	3	1	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. CIFE Publn. Training manual on culture of live food organisms for Aqua hatcheries,
2. MPEDA Publn. Hand book on Aqua farming – Live feed. Micro algal culture
3. LavensP.andSorgelose P. Manual on the production and use of live food for aquaculture.
4. Sorgelos, P. &Pandian, S. Culture of live food organisms with special reference to Artemia culture
5. ."Live Feeds in Marine Aquaculture" by Josianne G. Støttrup and Lesley A. McEvoy
6. "Microalgae: Biotechnology, Microbiology and Energy" edited by Michael A. Borowitzka and Navid R. Moheimani
7. "Practical Manual on Microbial and Algal Live Feed Culture for Aquaculture Nursery & Hatchery Operations" by Various Authors
8. "Artemia Biology and Cultivation: Practical Manual for Aquaculture" by Patrick Sorgeloos, Patrick Lavens, Léon P. Sorgeloos, and Wim Decleir
9. "Rotifers in Aquaculture" by Terry W. Snell, Atsushi Hagiwara, and Elizabeth J. Walsh
10. "Copepods in Aquaculture" by Cheng-Sheng Lee, Patricia J. O’Bryen, and Nancy H. Marcus

Programme	B. Sc. Aquaculture Honours					
Course Title	Fisheries Economics and Extension					
Type of Course	**Major** core					
Semester	VII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	___	The Fisheries Economics and Extension "course offers a deep dive into the economic principles and financial analyses crucial to the sustainable management and development of fisheries and aquaculture sectors. Through exploring topics such as market dynamics, international trade, and the socio-economic aspects of fisheries extension and cooperative development, students will gain the skills and knowledge necessary to address the complex challenges facing today's marine resource management.				

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the fundamental concepts of economics including demand, supply, and market structures within the fisheries and aquaculture sectors.	U	C	Written exams, quizzes
CO2	Apply economic principles to analyze fisheries management issues, focusing on elasticity of demand and the law of diminishing marginal utility.	Ap	C	Case studies, practical exams
CO3	Evaluate financial strategies and perform economic analyses in fisheries and aquaculture, including break-even analysis and	E	P	Project reports, presentations

	cost concepts.			
CO4	Develop comprehensive farm planning and budgeting strategies, and assess the feasibility and risks associated with fisheries projects.	C	P	Lab reports, group projects
CO5	Demonstrate an understanding of the role and impact of subsidies, international trade, and market dynamics on the fisheries sector.	An	C	Seminar presentations, written exams
CO6	Implement and evaluate fisheries extension programs, understanding the importance of cooperative development and institutional support in enhancing the socio-economic conditions of fishermen.	Ap	P	

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Introduction to Economics**		**10**
	1	Economics-definition, scope, Individual demand,	2
	2	Basic concept of economics -goods, services, wants, utility	3
	3	Demand and Supply	3
	4	Market demand, Value based Pricing and Cost Based pricing.	2
II	**Economic Principles in Fisheries Management**		**10**
	5	Elasticity of demand, Law of diminishing marginal utility..	3
	6	Supply and demand in fish markets	3
	7	Price determination and market structures	2
	8	International trade in fisheries	2
III	**Financial and Economic Analysis in Fisheries and Aquaculture**		**20**
	9	Break Even Analysis in fisheries	3
	10	Cost Concepts- Variable Cost, Fixed Cost, Total Cost,	2

	11	Junk Cost, Average Cost, Marginal Cost, Opportunity cost	2
	12	Farm planning, budgeting- Complete and Partial budgeting.	2
	13	Feasibility Analysis in fisheries Project- Introduction to Feasibility Analysis (Definition and importance).	2
	14	Risk and uncertainty. Sensitivity Analysis- Partial sensitivity analysis, Best Worst Scenario Analysis, Monte Carlo Analysis	2
	15	Time Value of Money.	2
	16	Economic principles of aquaculture	2
	17	The role and impact of subsidies	3
IV	**Fisheries Extension**		**8**
	18	Introduction to Fisheries education and fisheries management- Meaning objectives, principles, importance and scope in fisheries	2
	19	Fisheries Extension Methods- Individual, group and mass contact methods, their effectiveness, factors influencing their selection and use	2
	20	Extension Program Planning and Evaluation- Steps and importance, participatory planning process	2
	21	Extension Program Planning and Evaluation- Steps and importance, participatory planning process	1
	22	Emerging challenges and opportunities in fisheries extension	1
V	**Open ended Module Fisheries Cooperative Development and Institutional Support**		**12**
	1	Co-operation- basic principles, co-operative legislation and its administrative structure.	
	2	Fishermen co-operatives, its functions, village societies, producing and marketing apex societies. Financing and special problems of fishermen cooperatives and remedial measures.	
	3	Role of National Co-operative Development Corporation, FFDA, KVK, ADAK, NIFAAM, Matsyafed, KAVIL, FISHCOFED, NFDB, MPEDA, NIFPHATT and NABARD in uplifting the socio- economic conditions of fishermen	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3	2	1	2	1	3	2	2	1	2	1	2
CO 2	3	2	3	2	3	2	2	3	3	2	2	1	3
CO 3	2	2	3	3	2	3	2	2	3	3	2	1	3
CO 4	3	3	2	2	3	2	2	2	2	3	3	2	3
CO 5	2	2	1	3	2	3	3	3	1	2	2	2	2

CO 6	3	3	3	2	3	2	2	3	3	2	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested Readings

1. Andrew, P. Fish business management: strategy, marketing
2. Rao, P.S. Fisheries economics and management in India.
3. Shaug, Y.C. Aquaculture economics : Basic concepts and methods of analysis
4. FAO, Fisheries technical paper, 351. Economic engineering
5. Paul, A.S. Economics
6. Seijo, J.C. et al. FAO Fisheries technical paper 368. Fisheries bioeconomics
7. Rao, T. V. Readings in human resource development.

8. Ray, G. L. Extension communication and management.
9. Supe, S. V. An introduction to Extension Education

Programme	B. Sc. Aquaculture Honours
Course Title	Seed Production and Hatchery Management
Type of Course	**Major** core
Semester	VII
Academic Level	400-499

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The Seed Production and Hatchery Management course provides an in-depth exploration of the science and techniques behind successful hatchery management and seed production for a range of aquatic species, including fish and crustaceans. It covers induced breeding, hatchery layout design, live feed culture, and the application of modern technologies in aquaculture to ensure the sustainable growth and health of broodstock and larvae.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Master the principles of induced breeding, hatchery, nursery, and pond management for various fish and crustaceans.	Ap	P	Practical exams, project reports
CO2	Understand the reproductive biology and lifecycle of crustaceans, applying hatchery production techniques effectively.	U	C	Written exams, lab reports
CO3	Develop competencies in marine seed production, including techniques for crabs, lobsters, molluscs, and various marine fishes.	Ap	P	Case studies, practical exams
CO4	Implement live feed culture techniques and understand the role of artificial diets in larviculture.	Ap	P	Lab practicals, seminar presentations
CO5	Evaluate and apply strategies for monitoring and maintaining optimal water quality in hatchery environments.	An	C	Research projects, presentations
CO6	Analyze breeding strategies to ensure	An	P	Group projects, field trip reports

	healthy and genetically diverse seed stock, incorporating field insights from hatchery visits.			
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Hatchery, and Seed Production Technologies**		**10**
	1	Induced breeding in fishes Management of hatchery, nursery and rearing ponds.	2
	2	Seed production technology of carps, tilapia and catfish.	3
	3	Management of hatchery, nursery and rearing ponds	2
	4	Hatchery layout and designing. Recirculating hatchery systems	3
II	**Crustacean Reproduction and Hatchery Techniques**		**10**
	5	Reproductive biology and life cycle in crustaceans.	3
	6	Induced breeding in prawns and shrimps	3
	7	Hatchery production techniques of shrimp.	2
	8	Hatchery production techniques of *Macrobrachium rosenbergii*.	2
III	**Marine Seed Production: Techniques and Technologies**		**20**
	9	Natural breeding and seed resources of cultivable crabs, lobsters and molluscs.	3
	10	Seed production technique of mud crab	2
	11	Hatchery technology for lobsters	2
	12	Methods for spat collection	2
	13	Induced maturation, spawning and hatchery rearing of mussels, edible oysters and pearl oysters	2
	14	Marine and brakishwater fish seed production in India..	2
	15	Marine fish hatchery-general considerations	2
	16	Seed production techniques of Sea Bass.	2
	17	Seed production techniques Cobia and Groupers	3
IV	**Live Feeds and Artificial Diets**		**8**
	18	Live feed culture techniques..	2
	19	Mass production of algae for hatcheries.	2
	20	Artemia production techniques	2
	21	Culture of zooplanktons for larviculture	1
	22	Artificial feeds in larviculture	1
V	**Open ended module Water Quality, Breeding Strategies, and Field Insights**		**12**
	1	Techniques for monitoring and maintaining optimal water parameters to support the growth and health of broodstock and larvae.	
	2	Selection, conditioning, and breeding strategies to ensure healthy and genetically diverse seed stock	
	3	Visit to Hatcheries	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	2	1	3	2	3	3	2	2	3
CO 2	2	3	2	3	1	3	2	3	2	2	3	3	2
CO 3	3	2	3	1	2	2	3	3	3	2	2	2	3
CO 4	2	2	2	3	3	2	2	2	3	3	3	2	2
CO 5	2	1	3	2	3	3	3	2	2	3	2	3	2
CO 6	1	3	2	3	2	3	2	3	2	2	3	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested Reading

1. Fish and Fisheries of India by Jhingran VG
2. Hypophysation of Indian major carps by Chonder S.L
3. Advances in aquaculture by Pillay . T.V.R
4. Aquaculture Bardach, by Rhyther&McLarney
5. Cold water fisheries of India by V.G Jhingran&Saigal

   Hatchery production of penaeid prawn seed by Anon
6. A Guide to prawn farming in India by Anon
7. Manual on Seed Production of Carps. by FAO Peteri, S. Nandi & SN. Chowdhury
8. FISH Seed Production And Distribution In India - by FAO Anon
9. - Handbook of Fisheries and Aquaculture by Ayyappan, S
10. Breeding and Seed Production of Finfish and Shell Fish by PC Thomas, et al
11. Shrimp Seed Production And Farming by P C Thomas

VIIIth Semester Major Core courses

Programme	B. Sc. Aquaculture Honours					
Course Title	Sea weed Cultivation and Utilization					
Type of Course	**Major** core					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3		2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The "Seaweed Cultivation and Utilization" course covers the fundamentals of seaweed farming and its diverse applications, emphasizing sustainable practices and commercial viability..					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Master the fundamentals of seaweed biology, ecology, and the roles seaweeds play in marine ecosystems.	U	C	Written exams, quizzes
CO2	Acquire practical skills in seaweed cultivation, from site selection to harvesting, and address common cultivation challenges.	Ap	P	Practical exams, lab reports
CO3	Evaluate the use of seaweeds in various industries such as food, agriculture, cosmetics, and biofuels.	An	C	Case studies, project reports
CO4	Understand the regulatory frameworks, certification standards, and sustainability practices within the seaweed industry.	U	F	Quizzes, written exams
CO5	Apply innovative technologies and strategies for seaweed biorefinery, genetic engineering, and climate change mitigation.	Ap	P	Research projects, seminar presentations
CO6	Analyze the economic viability, market trends, and ethical	An	C	Group projects, presentations

	considerations in seaweed aquaculture to develop sustainable business models.			
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Seaweed Biology and Ecology**		**10**
	1	Fundamentals of Seaweed Biology Overview of seaweed classification, morphology, and life cycles.	2
	2	Ecological Roles of Seaweeds Seaweeds in marine ecosystems: biodiversity, habitat provision, and carbon sequestration.	3
	3	Seaweed Distribution and Habitat Global and local distribution patterns, habitat preferences, and environmental factors affecting growth	3
	4	Seaweed Biodiversity and Conservation Threats to seaweed habitats, conservation strategies, and sustainable management practices	2
II	**Seaweed Cultivation Techniques**		**10**
	5	Basics of Seaweed Farming Site selection, farm setup, and species selection for cultivation.	3
	6	Cultivation Methods Onshore, offshore, and integrated multitrophic aquaculture (IMTA) systems	3
	7	Harvesting Techniques Methods for sustainable harvesting, post-harvest handling, and processing	2
	8	Challenges and Solutions in Seaweed Cultivation Addressing common challenges such as disease, pests, and environmental impacts	2
III	**Seaweed for Industrial and Commercial Use**		**15**
	9	Food and Nutraceuticals Utilization of seaweeds in food industries and health supplements.	2
	10	Bioactive Compounds from Seaweeds Extraction and applications of bioactive compounds in pharmaceuticals	2
	11	Seaweeds in Agriculture Seaweed-based fertilizers and soil conditioners	2
	12	Cosmetics and Personal Care Products Application of seaweed extracts in cosmetics.	1
	13	Biofuels and Bioplastics Production of biofuels and bioplastics from seaweed biomass	1
	14	Integrated Uses of Seaweeds Waste treatment, carbon sequestration, and habitat restoration projects	1
	15	Seaweeds in Animal Feed Inclusion of seaweeds in aquaculture and livestock feed	2
	16	Innovative Products and Emerging Technologies	2

		Exploration of novel products and cutting-edge technologies in seaweed utilization	
	17	Economic Aspects and Market Trends Analysis of global markets, economic viability, and trends in seaweed industry	2
IV	**Policy, Regulation, and Sustainability in Seaweed Industry**		**10**
	18	Regulatory Frameworks for Seaweed Cultivation Domestic and international regulations affecting seaweed farming.	2
	19	Certification and Standards for Sustainable Seaweed Farming Organic and sustainability certifications in seaweed cultivation	2
	20	Environmental Impact Assessments Assessing and mitigating the environmental impacts of seaweed cultivation	2
	21	Social and Ethical Considerations Community engagement, ethical practices, and benefits to local communities	2
	22	Future Directions in Seaweed Sustainability Innovative practices for enhancing sustainability in the seaweed industry	2
V	**Practical module**		**30**
	1	Seaweed Species Identification: Seaweed Habitat Survey: Cultivation Techniques Spore Collection and Seeding: Nutrient Media Preparation Monitoring Growth Parameters Harvesting Techniques: Post-Harvest Processing: Seaweed Product Development: Quality Control and Testing:	
	2	Visit to farms	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	3	1	3	2	2	3	1	2	1
CO 2	3	3	2	1	2	3	2	3	3	2	2	3	1
CO 3	2	1	3	3	1	2	2	2	1	3	3	1	3
CO 4	1	3	2	2	3	1	1	3	2	1	2	3	2

CO 5	3	1	2	3	2	3	3	1	3	2	1	2	3
CO 6	2	3	1	1	3	2	2	2	3	3	3	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

<u>Suggested reading</u>

1. "Seaweed Ecology and Physiology" by Catriona L. Hurd, Paul J. Harrison, Kai Bischof, and Christopher S. Lobban
2. "Seaweeds: Edible, Available, and Sustainable" by Ole G. Mouritsen
3. "Handbook of Algal Technologies and Phytochemicals: Volume I: Food, Health and Nutraceutical Applications / Volume II: Phycoremediation, Biofuels and Global Biomass Production" edited by Gokare A. Ravishankar and Ambati Ranga Rao
4. "Advances in Seaweed Cultivation and Utilization in Europe" edited by Maeve Kelly and Annette Wilson

5. "Seaweed in Health and Disease Prevention" by Joël Fleurence and Ira Levine
6. "Marine Macrophytes as Foundation Species" edited by Emil Olafsson
7. "Sustainable Seaweed Technologies: Cultivation, Biorefinery, and Applications" edited by Maria Dolores Torres, et

Programme		B. Sc. Aquaculture Honours
Course Title		Deep Sea fisheries
Type of Course		**Major** core
Semester		VIII
Academic Level		400-499

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The course explores deep-sea fisheries, addressing their biodiversity, challenges, and environmental impacts, and highlights sustainability practices, technological advancements, and management strategies, with a special focus on India's deep-sea fishing sector

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the significance, biodiversity, and challenges of deep-sea fisheries.	U	C	Written exams, quizzes
CO2	Analyze the environmental impacts of deep-sea overfishing and the necessity for global management strategies.	An	C	Project reports, case studies
CO3	Apply knowledge of advanced technologies and methods for sustainable deep-sea fishing.	Ap	P	Lab practicals, presentations
CO4	Evaluate conservation strategies for protecting deep-sea biodiversity and implementing responsible fishing practices.	E	C	Research projects, group discussions
CO5	Create innovative solutions to address challenges and opportunities in deep-sea fisheries.	C	P	Seminar presentations, project reports
CO6	Understand and assess India's deep-sea fishing policies and management strategies.	U	F	Case studies, written exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Deep-Sea Fisheries: Exploration, Biodiversity, and Challenges**		**10**
	1	Overview of Deep-Sea Fisheries, Definition and significance of deep-sea fisheries,.	2
	2	Challenges and opportunities in deep-sea fishing,	3
	3	Biodiversity of Deep-Sea Ecosystems.	2
	4	Exploration of unique species in deep-sea environments, Adaptations of organisms to extreme condition	3
II	**"Deep-Sea Overfishing: Environmental Impacts and Global Management Strategies"**		**10**
	5	Overfishing and Environmental Impact.	3
	6	Assessment of overfishing in deep-sea environments, Environmental consequences of deep-sea trawling,.	3
	7	Management of Deep-Sea Fisheries.	2
	8	International cooperation in deep-sea fisheries	2
III	**Technologies, Conservation, and Sustainability in Deep-Sea Fishing**		**20**
	9	Deep-Sea Fishing Gear and Vessels,.	3
	10	Specialized equipment for deep-sea fishing	2
	11	Technological advancements in deep-sea trawling advancements	2
	12	Remote Sensing and Mapping for Deep-Sea Fisheries	2
	13	Utilizing technology for mapping and monitoring deep-sea ecosystems,	2
	14	Remote sensing applications in fisheries research	2
	15	Deep-Sea Fisheries Conservation, Conservation strategies for vulnerable deep-sea species.	2
	16	Importance of protecting deep-sea biodiversity, Implementing eco-friendly and responsible fishing practices.	2
	17	Sustainable Practices in Deep-Sea Fishing,	3
IV	**Deep-Sea Fisheries: Case Studies, Innovations, and Future Prospects"**		**8**
	18	Case Studies in Deep-Sea Fisheries	2
	19	Analysis of successful and unsuccessful deep-sea fisheries management. Lessons learned and best practices,	2
	20	Future Directions in Deep-Sea Fisheries	2
	21	Emerging technologies and research in deep-sea fisheries	1
	22	Addressing future challenges and opportunities	1
V	**Open ended module "Exploring India's Deep Sea Fishing: Resources, Policies, and Management"**		**12**
	1	Major deep sea fishery resources Deep sea fishery resources of India	
	2	Deep sea fishing policy of India	
	3		

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	3	2	3	2	1	2	2	3	1
CO 2	2	3	2	3	1	1	2	3	2	3	1	2	2
CO 3	3	1	3	2	2	3	3	2	3	1	3	1	3
CO 4	1	3	2	1	3	2	2	1	3	2	3	2	2
CO 5	2	1	3	3	2	1	1	2	2	3	2	3	3
CO 6	3	2	1	2	1	3	3	2	1	2	1	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4		✓	✓	✓
CO 5	✓	✓		✓
CO 6	✓		✓	✓

Suggested reading

1. Deep-Sea Fishes: Biology, Diversity, Ecology and Fisheries by Imants G.

2. "Deep-Sea Fisheries Biology" by Imants G. Priede
3. "The Sunken Billions: The Economic Justification for Fisheries Reform" by The World Bank and FAO
4. "The Deep: The Extraordinary Creatures of the Abyss" by Claire Nouvian
5. "Marine Biodiversity: Patterns and Processes, Assessment, Threats, Management and Conservation" edited by Héctor Reyes Bonilla
6. "Marine Conservation: Science, Policy, and Management" by G. Carleton Ray and Jerry McCormick-Ray
7. "Deep-Sea Fishing Policy of India" by the Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India

Programme		B. Sc. Aquaculture Honours
Course Title		Fish Population Dynamics
Type of Course		**Major** Core
Semester		VIII
Academic Level		400-499

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2 Hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The course on "Fish Population Dynamics" provides an in-depth exploration of the mechanisms that drive changes in fish populations, including growth, mortality, and recruitment strategies, alongside the application of mathematical models and software for fish stock assessment. It equips students with the analytical tools and ecological understanding necessary to assess, manage, and conserve fishery resources, addressing challenges like overfishing, habitat loss, and climate change impacts on aquatic ecosystems

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the basic concepts of stock, recruitment, growth rate, and mortality rate in fisheries.	U	C	Written exams, quizzes
CO2	Analyze the importance and application of Maximum Sustainable Yield (MSY) and its challenges in fisheries management.	An	C	Case studies, project reports
CO3	Apply principles of fish population dynamics to assess growth, mortality, and recruitment strategies using analytical and prediction models.	Ap	P	Practical exams, lab reports
CO4	Evaluate the effects of ecological factors like climate change and habitat usage on fish population dynamics.	E	C	Research projects, presentations
CO5	Utilize software applications and tools, including R program, for fisheries assessment and management.	Ap	P	Lab practicals, software simulations
CO6	Create sustainable fisheries management	C	P	Group projects, seminar presentations

	strategies considering technological, enhancement, and socio-economic aspects.			
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Stock Assessment and Management Principles"**		**10**
	1	Basic concepts: stock, recruitment, growth rate, and mortality rate...	2
	2	Importance of Stratified Random Sampling in Fisheries	3
	3	Maximum Sustainable Yield (MSY)- Definition and calculation of MSY	2
	4	Challenges and limitations in applying MSY to fisheries management	3
II	**Fish Population Dynamics: Growth, Mortality, and Recruitment Strategies"**		**10**
	5	Growth parameters - Length of infinity, Growth coefficient, VBGF equation, , Mortality parameters; Types of mortality; Estimation of total, natural and fishing mortality rates, Exploitation ratio, Exploitation rate.	3
	6	Principles of growth - Growth parameter estimation Gulland and Holt Plot, Ford – Walford plot & Chapman's method	3
	7	Mortality parameters; Types of mortality; Estimation of total, natural and fishing mortality rates, Exploitation ratio, Exploitation rate	2
	8	Recruitment and gear selectivity: Timing and size of recruitment. Factors influencing recruitment; Principle and estimation of gear selectivity trawl net and gill net selectivity	2
III	**"Fisheries Assessment: Models, Methods, and Software Applications"**		**20**
	9	Analytical models - Cohort dynamics and life history,	3
	10	Virtual population analysis	2
	11	Prediction models (Thompson and Bell model	2
	12	Yield per recruit model and Relative Yield per Recruit model)	2
	13	Surplus production models	2
	14	Holistic models: Schaefer's model, Fox model. Swept area method	2
	15	Software's - Software for fish stock assessment	2
	16	Computer based software's, FISAT, Monte Carlo simulations.	2
	17	R program: basics- Application of R program in fisheries	3
IV	**Ecological Foundations of Fish Population Dynamics"**		**8**
	18	Impact of life history strategies on population dynamics and fisheries management.	2
	19	Reproductive Biology and Its Impact on Population Dynamics	2
	20	Effects of Climate Change on Fish Populations	2
	21	Habitat Usage and Migration Patterns on Fish Populations	1
	22	Predator-Prey Interactions in Aquatic Ecosystems	1
V	**Open ended module Sustainable Fisheries: Technology, Enhancement, and Socio-economic Strategies**		**12**
	1	Fishing Technology and Bycatch Issues	
	2	Stock Enhancement and Rebuilding Strategies	
	3	Social and Economic Aspects of Fisheries Management	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	2	1	1	2	3	2	2	1	2	1	2
CO 2	2	3	2	3	2	3	2	3	2	3	2	2	3
CO 3	3	2	3	2	3	2	2	2	3	3	3	3	2
CO 4	1	2	2	3	3	1	1	2	2	2	3	2	3
CO 5	2	3	3	1	2	3	2	3	3	3	1	2	2
CO 6	3	2	3	3	2	2	3	2	3	2	2	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested Reading

1. On the Dynamics of Exploited Fish Populations by Beverton, R. J. H. & Holt, S. J.
2. Stock Assessment: Quantitative Methods and Applications for Small Scale Fisheries by Cailucci, V. G., Saila, S. B., Gustafson, D. J., & Rothschild, B. J.
3. Fish Population Dynamics: A Course Manual by Devaraj, M.
4. Fish Population Dynamics by Gulland, J. A.
5. A Review of Length-Based Approaches to Assessing Fish Stocks by Gulland, J. A.
6. Quantitative Fisheries Stock Assessment – Choice, Dynamics, and Uncertainty by Hilborn, R. & Walters, C. J.
7. Fisheries Biology, Assessment, and Management by King, M.
8. Fisheries Technical Paper No: 301 by FAO. (Manual)
9. Theory of Fish Population Dynamics: As the Biological Background for Rational Exploitation and Management of Fishery Resources by Nikolsky, G. V.
10. Selection of Simple Methods for the Assessment of Tropical Fish Stocks by Pauly, D.
11. Quantitative Fish Dynamics by Quinn, T. J. & Deriso, R. B.
12. Methods for the Assessment of Fish Production in Freshwaters by Ricker, W. E.
13. Introduction to Tropical Fish Stock Assessment. Part 1. Manual by Sparre, P. & Venema, S. C.
14. Stock Assessment of Tropical Marine Fishes by Vivekanandan, E.
15. Ecopath with Ecosim: A User’s Guide by Christensen, V., Walters, C. J., & Pauly, D.
16. FISAT II - FAO-ICLARM Stock Assessment Tools II: User’s Guide by FAO.
17. TropFishR: An R Package for Fisheries Analysis with Length-Frequency Data by Mildenberger, T., Taylor, M. H., & Wolff, M.

VIIIth Semester

Research methodology

Programme	B. Sc. Aquaculture Honours					
Course Title	Research Methodology					
Type of Course	**Major**					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology. Should have completed previous semesters					
Course Summary	The course on research methodology delves into the essentials of designing and executing scientific research in the aquaculture field, covering everything from formulating hypotheses to ethical considerations and statistical analysis. It aims to equip students with the skills needed to critically assess research problems, develop robust study designs, and effectively communicate their findings, preparing them for advanced research and professional practice in aquaculture management.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the distinctions between pure, applied, and action research, including research ethics.	U	C	Written exams, quizzes
CO2	Identify and select research problems, conduct a literature review, and develop a research hypothesis.	Ap	P	Project reports, literature reviews
CO3	Design a research study applying appropriate research designs and statistical analysis techniques.	Ap	P	Lab reports, data analysis assignments
CO4	Master the preparation of research proposals and understand the process of submission to funding agencies.	Ap	P	Seminar presentations, project proposals
CO5	Acquire skills in academic writing, including structuring research papers, thesis, and understanding citation styles.	Ap	C	Research papers, thesis writing

CO6	Utilize digital libraries and internet resources effectively for literature collection and research.	Ap	P	Practical exams, online research tasks

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Foundations of Research:**		**10**
	1	Types of Research: Pure, Applied and Action Research. Research Ethics	2
	2	Kinds of Research: Diagnostic, Descriptive, Exploratory, Explanatory.	3
	3	Research Ethics, Animal ethics; Human ethics.	3
	4	Biosafety in research	2
II	**Formulating and Proposing Research:**		**10**
	5	Identification and selection of research problems,	3
	6	Literature search and Review of Literature.	3
	7	Formulation of Hypothesis. Hypothesis Testing and estimation	2
	8	Preparation of research proposal and submission of research project proposals to funding agencies	2
III	**Research Design and Statistical Analysis in Scientific Research"**		**20**
	9	Need for research design.	3
	10	Features of good Research designs	2
	11	Types of research design Descriptive design, case control, cohort, cross sectional, longitudinal	2
	12	Basic principles of experimental design	2
	13	CRD and Quasi-Experimental designs	2
	14	Collection of Data: Primary Data, Secondary data, Data Collection methods	2
	15	Sampling Technique	2
	16	Data Analysis, , tabulations, classifications, Interpretations	2
	17	Statistics in Research:	3
IV	**Academic Writing and Research Methodology**		**8**
	18	Research paper, reviews, synopsis,	2
	19	Structure of Thesis	2
	20	Components of a research articles, role of author, guide, co-authors.	2
	21	Conference papers and project reports	1
	22	Citation styles: Footnotes, abbreviations	1
V	**Open ended Module Literature Collection**		**12**
	1	Collection of literature- News articles – Newsletters – Magazines – Books - Journals virtual sources – other sources. Short communications –review articles	
	2	Digital library and search of articles - Keywords and search - Internet – Google Scholar, PubMed ,Inflibnet ,Medline, Agricola ,Science direct	
	3	Open access Journals -	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3	2	1	2	1	3	2	2	1	2	1	2
CO 2	3	2	3	2	3	2	2	3	3	2	3	2	3
CO 3	3	2	2	3	1	3	3	2	3	3	2	3	2
CO 4	2	3	3	1	2	2	2	3	3	2	3	2	3
CO 5	2	1	3	2	3	3	2	2	3	3	1	3	2
CO 6	1	2	2	3	2	2	1	2	2	3	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	
CO 3	✓	✓	✓	✓
CO 4		✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	

Suggested reading

1. Thesis and Assignment Writing by Anderson, D., Durston, B., & Polle, M.
2. The Craft of Research by Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., & FitzGerald, W. T.
3. Research Methodology by Rajendrakumar, C.
4. Research Methodology: Methods and Techniques by Kothari, C. R.
5. Research Methodology for Biological Sciences by Gurumani, N.
6. Essentials of Research Design and Methodology by Marczyk, G., DeMatteo, D., & Festinger, D.
7. From Research to Manuscript: A Guide to Scientific Writing by Katz, M. J.
8. The Craft of Scientific Writing by Alley, M.
9. Writing Scientific Research Articles: Strategy and Steps by Cargill, M., & O’Connor, P.
10. The Elements of Technical Writing by Blake, G., & Bly, R. W.
11. Technical Writing: Principles, Strategies, and Readings by Reep, D. C.

VIII semester

Electives

Programme	B. Sc. Aquaculture Honours					
Course Title	Endocrinology of Fish					
Type of Course	**Major** Elective					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2 hours
Pre-requisites	A pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	This course provides a comprehensive overview of fish endocrinology, focusing on hormonal systems and their roles in regulating physiological processes crucial for aquaculture. Students will gain insights into hormonal functions, adaptations, and manipulations for aquaculture practices.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand and describe the basic and complex hormonal systems in fish, their chemical structures, and physiological functions.	Understand (U)	Conceptual Knowledge (C)	Written exams, Quizzes
CO2	Apply knowledge of hormonal mechanisms and pathways to assess and improve fish health and growth in aquaculture.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, Lab reports
CO3	Analyze the effects of environmental changes and endocrine disruptors on fish hormonal systems and propose mitigation strategies.	Analyze (An)	Conceptual Knowledge (C)	Case studies, Project reports
CO4	Evaluate and critique current research and technologies in fish endocrinology, assessing their practical applications and limitations.	Evaluate (E)	Conceptual Knowledge (C)	Research projects, Seminar presentations

CO5	Create innovative approaches to manipulate hormonal levels for enhanced breeding and stress management in aquaculture settings.	Create (C)	Procedural Knowledge (P)	Lab practicals, Group projects
CO6	Develop a comprehensive understanding of future trends in fish endocrinology research, focusing on sustainability and ethical considerations.	Understand (U)	Metacognitive Knowledge (M)	Presentations, Research projects
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Fundamentals of Endocrinology in Fish**		**10**
	1	Introduction to Endocrinology – Basic concepts and significance in aquaculture..	2
	2	Hormonal Classification – Types of hormones and their chemical structures	3
	3	Mechanisms of Hormone Action – Receptors, signaling pathways, and feedback loops	3
	4	Comparative Endocrinology – Differences and similarities in hormonal systems across various fish species	2
II	**Hormonal Regulation in Fish**		**10**
	5	Growth Hormones – Roles and regulation of growth in fish.	3
	6	Reproductive Hormones – Mechanisms controlling reproductive cycles and behaviors	3
	7	Thyroid Hormones – Influence on metabolism and development.	2
	8	Cortisol and its effects on fish health and disease resistance	2
III	**Advanced Topics in Fish Endocrinology**		**20**
	9	Hormonal adaptations to environmental stressors.	3
	10	Photoperiod and seasonal effects on hormone regulation.	2
	11	Endocrine disruptors and their impact on fish health.	2
	12	Techniques in manipulating hormonal levels for enhanced breeding.	2
	13	Case studies on hormonal treatment successes and failures.	2
	14	Future trends in hormonal research in aquaculture	2
	15	Genetic and epigenetic influences on hormone functions.	2
	16	Neuroendocrine control in fish.	2
	17	Practical sessions involving hormone assays and interpretation	3
IV	**Practical Applications of Endocrinology in Aquaculture**		**8**
	18	Hormone therapies in fish farming – applications and considerations	2
	19	Diet and hormones – Nutritional strategies to modulate hormonal responses.	2
	20	Handling and transport – Minimizing stress through hormonal	2

		understanding	
	21	Disease control – Using hormonal insights for prevention and treatment.	1
	22	Breeding technologies – Hormonal manipulation for improved reproduction.	1
V	**Open ended module Research Trends and Future Directions**		**12**
	1	Recent advances in fish endocrinology research. Biotechnological interventions in hormonal control	
	2	Impacts of climate change on hormonal adaptation.	
	3	Sustainability and ethical considerations in hormonal manipulation.	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed modul

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	1	1	1	1	3	1	1	1	2	1	2
CO 2	3	2	1	2	1	2	2	2	3	2	3	1	2
CO 3	2	2	1	2	1	1	2	1	1	1	3	2	1
CO 4	3	1	2	2	2	2	3	2	2	2	3	1	3
CO 5	3	1	3	2	3	1	1	3	3	2	2	1	3
CO 6	1	1	1	3	1	1	1	2	1	1	1	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓

CO 3	✓	✓		
CO 4	✓	✓		✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓		✓

Suggested reading

1. "Fish Physiology: Fish Endocrinology" by Peter Thomas and Reinhold H. A. M. Vaudry
2. "Fish Biochemistry and Molecular Biology" by Elisabeth M. Plisetskaya
3. "Endocrinology of Fishes" by N. Ma. Sundararaj
4. "Environmental Endocrinology in Aquatic Organisms" edited by Taisen Iguchi and Yoshinao Katsu
5. "Practical Manual of Fish Biology" by Chris Brown
6. "Biotechnology Applications in Fish Endocrinology" edited by Z. Kulbir Singh
7. "Hormones and Reproduction of Vertebrates - Volume 1: Fishes" edited by David O. Norris and Kristin H. Lopez
8. "Aquatic Animal Health and Hormones: Techniques and Therapies" by Clifford P. Bond

Programme	B. Sc. Aquaculture Honours					
Course Title	Fish Immunology					
Type of Course	**Major** Elective					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course on “Fish Immunology “delves into the intricate immune mechanisms of fish and shellfish, exploring the basics of immunity, the impact of environmental factors, and the practical applications of immunological knowledge in aquaculture. It equips students with an understanding of immune responses, vaccination strategies, and immunological techniques, preparing them for advanced studies and careers in fish health and disease management.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the basic structure and function of immune systems in vertebrates, focusing on aquatic organisms.	U	C	Written exams, quizzes
CO2	Analyze the influence of environmental factors on the immune responses of fish and invertebrates.	An	C	Case studies, project reports
CO3	Apply knowledge of immunoglobulins in fish to practical scenarios, including their production and applications.	Ap	P	Practical exams, lab reports

CO4	Evaluate different types of immunity and immune responses in fish, understanding cellular and humoral immunity mechanisms.	E	C	Seminar presentations, research projects
CO5	Design vaccination strategies and immunization protocols for disease prevention in aquaculture settings.	C	P	Group projects, presentations
CO6	Utilize immunological techniques such as immunohistochemistry, ELISA, and flow cytometry for fish disease research and management.	Ap	P	Lab practicals, research projects
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Immune Systems in Aquatic Organisms: Basics and Environmental Effects**		**10**
	1	Overview of the immune system in vertebrates	2
	2	Basic principles of immune system in fishes and shell fish Organs and cells involved in immunity	3
	3	Environmental Influences on Fish Immunity	3
	4	Invertebrate immune response	2
II	**Immunoglobulins in Fish: Structure, Functions, and Applications**		**10**
	5	Structure and types of immunoglobulin, Functions of immunoglobulin, ,	3
	6	Monoclonal Antibodies,	3
	7	Production and Applications of Immunoglobulin	2
	8	Immuno-stimulant and immunomodulation	2
III	**Immunity Types, Responses, and Mechanisms in Fish Immunology**		**20**
	9	Types of immunity Passive immunity, Active immunity, Herd Immunity, Innate immunity	3
	10	Types of Immune Response	2
	11	Cell mediated Immunity	2
	12	T-cells, T-cell receptors, T-cell maturation, activation, differentiation.	2
	13	Humeral immunity	2
	14	B-cells Antigens and Antibodies	2
	15	Aantimicrobial and antitumor substances	2
	16	Immune responses to infection, inflammation.	2
	17	Cytokines &Antagonists	3
IV	**Systems, Responses, and Vaccination**		**8**

	18	Compliment System-components & functions.	2
	19	Compliment activation and regulations.	2
	20	Inflammation & hypersensitivity.Immune system in relation to parasitic infections	2
	21	Principles of vaccination in fish	1
	22	Current vaccines and immunization strategies	1
V	**Open ended Module Immunological Techniques in Fish Research**		**12**
	1	Immunohistochemistry, ELISA, flow cytometry	
	2	Molecular methods for studying fish immunity	
	3	Case studies of disease outbreaks and management	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	1	2	3	2	1	2	2	1	2
CO 2	2	3	2	3	2	1	2	3	2	3	1	2	3
CO 3	2	2	3	1	3	2	2	2	3	2	2	3	2
CO 4	3	1	2	3	2	3	3	2	2	3	3	2	3
CO 5	2	3	3	2	1	2	2	3	3	2	1	3	2
CO 6	1	2	3	2	3	2	1	2	3	3	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested Readings:

1. Immunology by Kindt, T. J.
2. Fundamental of Immunology by Paul, W. P.
3. Immunology by Goldsby, R. A.
4. Cellular and Molecular Immunity by Abbas, K. and Lichtman, A. H.
5. Immunology and Serology by Carpenter.
6. Modern Immunology by Das Gupta
7. Essentials of Clinical Immunology by Chapel, H., Haeney, M., Misbah, S., & Snowden, N.
8. Basic Immunology: Functions and Disorders of the Immune System by Abbas, A. K., & Lichtman, A. H.
9. The Immune System by Parham, P.
10. Janeway's Immunobiology by Murphy, K., & Weaver, C.
11. Mucosal Immunology by Mestecky, J., Bienenstock, J., Lamm, M. E., Mayer, L., McGhee, J. R., & Strober, W.

Programme	B. Sc. Aquaculture Honours					
Course Title	Organic Aquaculture					
Type of Course	**Major** (Elective)					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2hours
Pre-requisites	A pass in HSE/VHSC or Equivalent with Biology. Should have completed previous semesters					
Course Summary	The "Organic Aquaculture" course provides an in-depth exploration of the principles, practices, and challenges of organic aquaculture, including regulatory frameworks, sustainability, and environmental stewardship. It equips students with the knowledge and skills to implement ethical and profitable organic aquaculture operations, emphasizing disease management, feed formulation, and marketing strategies within a global context.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Grasp the definition, principles, history, and global trends of organic aquaculture.	U	C	Written exams, quizzes
CO2	Understand and differentiate between organic and conventional aquaculture practices, including regulatory frameworks.	U	C	Quizzes, written exams
CO3	Apply principles of organic broodstock management, hatchery operations, and sustainable practices in aquaculture.	Ap	P	Practical exams, lab reports
CO4	Analyze and implement organic feed formulation, disease prevention, and water quality management strategies.	An	P	Case studies, project reports
CO5	Develop biosecurity plans, minimize environmental impacts, and integrate aquaculture with	C	P	Seminar presentations, research projects

	ecosystem health.			
CO6	Evaluate the economic feasibility, profitability, and effective marketing strategies for organic aquaculture products.	E	C	Group projects, presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Organic Aquaculture**		**10**
	1	Definition and principles of organic aquaculture	2
	2	History and global development of organic aquaculture	3
	3	Regulatory framework for organic aquaculture certification (domestic and international)	3
	4	Comparison of organic vs. conventional aquaculture practices	2
II	**Hatchery operation**		**10**
	5	Suitable species for organic aquaculture (finfish, shellfish, seaweed)	3
	6	Organic broodstock management and selection	3
	7	Hatchery and nursery operations in organic aquaculture	2
	8	Sustainable stocking densities and carrying capacities	2
III	**Feeding and Disease prevention**		**20**
	9	Feed formulation and sourcing for organic aquaculture	3
	10	Organic nutrient sources and fertilization strategies	2
	11	Maintaining water quality and soil health in organic aquaculture system	2
	12	Disease prevention strategies in organic aquaculture	2
	13	Non-chemical parasite control methods	2
	14	Importance of maintaining fish health and resilience	2
	15	Water quality parameters crucial for organic aquaculture	2
	16	Monitoring and maintaining optimal water quality conditions	2
	17	Aeration and biofiltration techniques in organic systems	3
IV	**Sustainable management strategies**		**8**
	18	Biosecurity plan development for organic aquaculture operations	2
	19	Minimizing environmental impact of organic aquaculture	2
	20	Integrating organic aquaculture with ecosystem health	2
	21	Economic feasibility and profitability of organic aquaculture	1
	22	Marketing strategies for organic aquaculture products	1
V	**Open ended module**		**12**
	1	Regulatory Framework Permitted Inputs and Practices: Water Quality and Disease Management practices required for Certification Habitat Management and Sustainability:	
	2	Traceability and Labeling:	
	3	Case studies and future of Organic aquaculture	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3	1	2	3	2	3	2	1	2	3	2	1
CO 2	3	1	2	3	2	1	2	3	2	1	2	3	2
CO 3	2	3	3	1	2	3	3	1	3	2	1	2	3
CO 4	3	2	1	3	1	2	1	2	3	3	2	1	2
CO 5	1	2	3	2	3	1	2	1	2	3	3	2	1
CO 6	3	1	2	1	2	3	3	2	1	2	1	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. Organic Aquaculture: Impacts and Future Developments edited by Lembo, G., & Mente, E.
2. Food System Transparency: Law, Science, and Policy of Food and Agriculture by Steier, A., & Friedlander, G.
3. The World of Organic Agriculture: Statistics and Emerging Trends 2008 by Yussefi-Menzler, M., & Willer, H.
4. Private Standards and Certifications in Fisheries and Aquaculture: Opportunities for Developing Countries by Washington, S., & Ababouch, L.
5. Ecological Aquaculture by Costa-Pierce, B. A.
6. Organic Aquaculture: Impacts and Future Developments edited by Asche, Frank and Bjørndal, Trond
7. Aquaculture: Principles and Practices by Pillay, T.V.R. and Kutty, M.N.
8. Organic Shrimp Farming: Environmental and Social Aspects by Macek, Patricia M.
9. Guidelines for the Organic Certification of Aquatic Animals by the International Federation of Organic Agriculture Movements (IFOAM)
10. Organic Aquaculture in Europe by the European Aquaculture Society

Programme	B. Sc. Aquaculture Honours
Course Title	Fisheries Oceanography
Type of Course	**Major** Elective
Semester	VIII
Academic Level	400-499

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours

Pre-requisites	A pass in HSC/VHSC or equivalent with biology.Should have completed previous semesters
Course Summary	This course on Fisheries Oceanography" delves into the intricate relationships between marine organisms and their environments, emphasizing the importance of physical, chemical, and biological processes in the ocean. It equips students with the knowledge and skills to apply advanced oceanographic techniques and ecological principles towards the conservation and sustainable management of marine resources.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the geographical, chemical, and physical properties of world oceans, including the marine environment.	U	C	Written exams, quizzes
CO2	Analyze the physico-chemical features and biological divisions of the marine environment affecting fisheries.	An	C	Project reports, case studies
CO3	Apply knowledge of marine ecology, trophic dynamics, and oceanographic processes to sustainable fisheries management.	Ap	P	Lab practicals, presentations
CO4	Evaluate the impact of climate phenomena like ENSO on marine ecosystems and their implications for fisheries.	E	C	Research projects, group discussions
CO5	Design conservation strategies based on marine biodiversity to	C	P	Seminar presentations, project reports

	support sustainable fisheries and ocean health.			
CO6	Utilize modern oceanographic tools and technologies for data collection and fish stock assessment.	Ap	P	Practical exams, field trip
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**World Oceans: Geography, Chemistry, and Physical Properties"**		**10**
	1	Salient features of world oceansa	2
	2	Oceanographic features of Arabian Sea, Bay of Bengal and Andaman Se	3
	3	Elemental composition of seawater..	3
	4	Chemical and physical properties of sea water- temperature, salinity, density, light, pressure, colour	2
II	**Marine Environment: Physical Processes and Chemical Features"**		**10**
	5	Physico-chemical features of Marine environment-, waves,	3
	6	Tides, currents and waves	3
	7	Monsoon cycles	2
	8	Upwelling and Mud banks	2
III	**Marine Ecology and Oceanography:**		**20**
	9	General characteristics of the marine environment.	3
	10	Zonation of sea.	2
	11	Biological divisions of the sea.	2
	12	Intertidal environment Adaptations of intertidal organisms.	2
	13	Intertidal rocky, sandy, and muddy shore associated fauna and their adaptations	2
	14	Deep Ocean Topographic features Deep sea adaptations.	2
	15	Population of the oceans - phytoplankton, zooplankton, benthos, and nekton	2
	16	Marine food chains and food webs	2
	17	Basics of marine ecology and trophic dynamics	3
IV	**Climate & Oceanography: Shaping Sustainable Fisheries"**		**8**
	18	El Nino Southern Oscillation (ENSO). -	2
	19	Upwelling and fisheries	2
	20	Climate change and fisheries.	2
	21	Oceanography In relation to fisheries.	1
	22	Marine Biodiversity and Conservation Strategies in Fisheries	1
V	**Open ended module**		**12**
	1	Oceanographic sampling and data collection methods Remote sensing and satellite oceanography	
	2	Acoustic methods for fish stock assessment	
	3	Emerging technologies in oceanographic research Field trips to coastal and marine research facilities	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	3	1	3	2	1	2	2	3	1
CO 2	2	3	2	3	2	2	2	3	2	3	1	2	2
CO 3	3	1	3	2	1	3	3	2	3	1	3	2	3
CO 4	1	2	3	2	3	2	2	1	2	3	2	3	3
CO 5	2	3	2	1	3	3	1	3	3	2	3	1	2
CO 6	3	1	2	3	2	1	3	2	1	3	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4		✓	✓	✓
CO 5	✓	✓		✓
CO 6	✓		✓	✓

Suggested reading

1. Fisheries Oceanography and Ecology by Laevastu, T.
2. Fisheries Oceanography by Harrison, P. J., & Parsons, T. R.
3. Biological Oceanography: An Introduction by Lalli, C., & Parsons, T. R.
4. The Future of Fisheries: A Trash Talk Guide by Pauly, D.
5. Invitation to Oceanography by Levin, P. A., & McKee, P. A.
6. Marine Fisheries Ecology by Mangel, M.
7. Ocean Remote Sensing and Ocean Colour by Mobley, C.

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquatic Pollution and Toxicology					
Type of Course	**Major** (Elective)					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	4	4			60	2 hours
Pre-requisites	A pass in HSC/VHSC or equivalent with biology/ should have completed previous semesters					
Course Summary	This course on "Water Pollution: Causes, Consequences, and Treatment" delves into the critical issues surrounding aquatic pollution, exploring the types, sources, impacts, and the latest methods for monitoring, testing, and treating contaminated water. It aims to equip students with a deep understanding of environmental toxins, advanced wastewater treatment technologies, and the principles of ecotoxicology, preparing them for effective management and conservation efforts in aquatic environments					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Identify and categorize the types, sources, and impacts of water pollution.	U	F	Written exams, quizzes
CO2	Analyze water quality parameters and understand their implications for aquatic health and safety.	An	C	Lab reports, practical exams
CO3	Evaluate the effectiveness of different wastewater treatment methods (primary, secondary, tertiary).	E	P	Project reports, presentations
CO4	Comprehend the mechanisms of toxicity, entry, and impact of toxicants in aquatic environments.	U	C	Quizzes, case studies
CO5	Apply modern toxicity testing methods (in vitro, in vivo, microbiological) to assess environmental health.	Ap	P	Lab practicals, research projects
CO6	Develop strategies for managing ecosystem health amidst challenges like bioaccumulation and	C	C	Seminar presentations, group project

	pollution.			

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Water Pollution: Causes, Consequences, and Treatment**		**10**
	1	The Nature of Water Pollution(Types ,Sources and Impact)	3
	2	Understanding Water Quality Parameters (BOD,COD etc)	2
	3	Investigating Water Pollution - Case Studies	3
	4	Wastewater treatment: Primary, Secondary and tertiary	2
II	**Understanding Environmental Toxins**		**10**
	5	Introduction to Toxicity and Toxicants	3
	6	Entry of Toxicants into the Environment	3
	7	Cycles and Residence Time of Toxicants	2
	8	Toxicity of Specific Contaminant Groups	2
III	**Unveiling Toxicity: A Comprehensive Exploration of Testing Methods**		**20**
	9	Introduction to Toxicity Testing	3
	10	Principles of Toxicity Testing	2
	11	In Vitro Toxicity Testing	2
	12	In Vivo Toxicity Testing	2
	13	Monitoring Approaches for Environmental Toxicity	2
	14	Microbiological Toxicity Testing	2
	15	Bio-sensors and Biomarkers	2
	16	Molecular Markers of Toxicity	2
	17	Emerging Technologies in toxicity testing	3
IV	**Core Principles of Ecotoxicology**		**8**
	18	Toxicants and Communities	2
	19	Multilevel Interactions and Toxic Effects	2
	20	Bioaccumulation and Biomagnification	2
	21	Sensitivity and Resilience of Ecosystems	1
	22	Managing Ecosystem Health	1
V	**Open Ended module**		**12**
	1	Emerging Toxicants and Environmental Changes Microplastics and Persistent Organic Pollutants Environmental Regulations and Policy	
	2	Toxicology and Human Health	
	3	Case Studies in Ecotoxicology	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	2	2	3	1	3	2	1	3	2	2	1
CO 2	2	3	2	1	2	3	2	3	2	2	3	1	2
CO 3	1	2	3	3	1	2	1	2	3	1	2	3	3
CO 4	2	2	1	3	2	3	2	2	2	3	1	3	2
CO 5	3	1	3	2	3	2	3	3	1	2	3	2	3
CO 6	2	3	2	1	3	3	2	1	3	3	2	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested Reading

1. Ecological Toxicity Testing edited by Cairns Jr, J. & Niederlehner, B. R.
2. Toxicology: The Basic Science of Poisons edited by Casarett and Doull.
3. Basic Environmental Toxicology by Cockerham, L. G. & Shane, B. S.
4. Environmental Ecology edited by Freedman, B.
5. Introduction to Environmental Toxicology by Landis, W. G. & Yu, M.-H.
6. Ecotoxicology by Moriarty, F.
7. Toxicology Principles and Applications by Niesink, J. M., De Vries, & Hollinger, M. R.
8. Pollutants & Their Eco-toxicological Significance by Nurenberg, H. W.
9. Ecotoxicology by Ramada, F.
10. Environmental Toxicology Assessment by Richardson, M.
11. Organometalics in Environment and Toxicology by Sigel, A. et al.
12. Principles of Toxicology edited by Stina, K. E. & Brown, T. M.

Programme	B. Sc. Aquaculture Honours
Course Title	Fisheries Business Management
Type of Course	**Major** Elective
Semester	VIII
Academic Level	400-499

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	4			60	2hours

Pre-requisites	A pass in HSE?VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The course delves into the essentials of fish business management, spanning strategic planning, organizational dynamics, and leadership in the seafood industry, enriched with case studies on aquaculture and seafood exports to highlight practical applications in global fisheries management.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Master the fundamental concepts of management processes and functions, and understand the distinct roles of managers in business management and administration.	U	C	Written exams, quizzes
CO2	Analyze the dynamics of fish capture, culture, domestic and export seafood businesses, incorporating strategic planning and forecasting.	An	C	Project reports, case studies
CO3	Design an organizational structure suited to the seafood industry, understanding formal and informal organizations and departmentalization strategies.	Ap	P	Presentations, organizational charts
CO4	Apply principles of human resource management in the seafood industry, focusing on staffing, selection processes, and promoting a culture of safety and compliance.	Ap	P	Practical exams, HR development plans
CO5	Evaluate leadership theories and human factors in business management, aligning individual and	E	C	Seminar presentations, leadership analysis

	organizational objectives for enhanced managerial effectiveness.			
CO6	Implement controlling systems and processes within fisheries business management, utilizing budgeting and technological tools for effective international management.	Ap	P	Case studies, management simulation exercises
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**"Fundamentals of Fish Business Management and Operations"**		**10**
	1	Management process, Functions of management,	2
	2	Role of a manager in business Management and administration	3
	3	Types of fish businesses- Fish capture and culture business,	3
	4	Domestic and export seafood business	2
II	**Strategic Planning and Forecasting in Fisheries Management"**		**10**
	5	Planning: Nature & Purpose	3
	6	Objectives and Managing by Objectives	3
	7	Forecasting in Fish Production and Marketing	2
	8	Case studies from seafood processing and export business and aquaculture business	2
III	**"Organizational Structure and Human Resources in Seafood Industry Management"**		**20**
	9	Nature and Purpose of Formal and Informal Organizations Departmentalization Strategies	3
	10	Organizational Chart: Understanding Structure and Process	2
	11	Line and Staff Authority: Benefits and Limitations	2
	12	Decentralization and Delegation of Authority	2
	13	Staffing and Selection Process: Techniques	2
	14	Human Resource Development and Managerial Effectiveness	2
	15	Role of HR in Promoting a Culture of Safety and Compliance	2
	16	Methods for Assessing and Enhancing Employee Performance	2
	17	Case Studies: Organizing in Seafood Production, including insights from seafood processing, export business, and aquaculture operations	3
IV	**"Leadership and Human Factors in Business Management"**		**8**
	18	Understanding the scope and importance of directing in business management.	2
	19	Exploring the role of human factors in the workplace, including creativity and innovation	2
	20	Techniques for aligning individual and organizational objectives.	2
	21	Overview of leadership and its significance in directing.	1
	22	Maslow's Hierarchy of Needs and its application in the workplace.	1
V	**Open ended module Controlling in Fisheries Business Management"**		**12**

	1	Controlling Systems and Processes Budgeting and Technological Tools for Control	
	2	International Management and the Global Fisheries Environment	
	3	Case Studies: Global Fisheries Management	

Note: The course is divided into five modules, with four having total 22 fixed units and one open-ended module with a variable number of units. There are total 48 instructional hours for the fixed modules and 12 hours for the open-ended one. Internal assessments (30 marks) are split between the open-ended module (10 marks) and the fixed modules (20 marks). The final exam, however, covers only the 22 units from the fixed module

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3	1	2	2	3	3	2	2	1	3	2	1
CO 2	3	2	3	2	1	2	2	3	3	2	2	3	2
CO 3	2	1	3	3	3	1	2	2	3	3	1	2	3
CO 4	3	3	2	1	2	3	3	3	2	2	2	3	1
CO 5	1	2	3	2	3	2	1	2	3	3	3	2	2
CO 6	2	1	2	3	3	2	2	3	1	3	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics: Assignment, Seminar presentation, Internal exam, End semester exa
Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. Fish Business Management: Strategy, Marketing, Development by Palfreman, A. (1999)
2. Business Management and Leadership Strategies: How to Lead and Succeed in the Competitive Market by Ahmed, J.
3. Business Management by Hoang, P. (IBID Press)
4. Organizational Behavior: An Indian Adaptation by Uhl-Bien, M., Schermerhorn Jr., J. R., et al.
5. Organizational Behavior by Vohra, N., Robbins, S. P., & Judge, T. A. (2022, 18th ed., updated)
6. A Textbook Of Organisational Behaviour by Gupta, C.B.
7. Strategic Management and Business Policy: Globalization, Innovation and Sustainability by Pearson (15th ed.)
8. Basics of Fish Farming for the Beginners: Easy Part-time Business from Your Backyard by Jayakumar, S.
9. Export Import Management by Paul, J., & Aserkar, R. (2nd ed.)

Multi-disciplinary courses (MDC)

	Course code	Course title	Hours	Credit
1	AQC1FM105	Fish as Food: Nutrition and Beyond"	**3**	**3**
2	AQC2FM106	Marine Biodiversity and Conservation	**3**	**3**

Programme		B. Sc. Aquaculture Honours				
Course Title		Fish as Food: Nutrition and Beyond"				
Type of Course		**MDC**				
Semester		I				
Academic Level		100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	3	3		0	45	1 ½ hours
Pre-requisites		A Pass in HSE/VHSE or Equivalent with biology				
Course Summary		The course delves into fish nutrition's health benefits and environmental sustainability, highlighting dietary roles, global consumption trends, and sustainable practices in aquaculture.				

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the nutritional value of fish in a balanced diet, focusing on omega-3 fatty acids, vitamins, and minerals.	U	C	Written exams, quizzes
CO2	Evaluate the health benefits and risks associated with fish consumption, including the impact of mercury and PCBs.	E	C	Case studies, project reports
CO3	Analyze global trends in fish consumption, food security, and the role of fish in traditional diets.	An	C	Research projects, presentations
CO4	Apply knowledge of fish quality and safety in culinary practices to enhance nutrient retention and develop sustainable seafood menus.	Ap	P	Practical exams, lab reports, culinary workshops
CO5	Create strategies for sustainable fish consumption and nutritional security, leveraging innovations in aquaculture.	C	P	Group projects, seminar presentations
CO6	Assess the role of policy, governance, certification, and labeling in promoting sustainable fisheries and nutritional interventions.	An	F	Written exams, quizzes, panel discussions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Fish Nutrition and Health Benefits**		**8**
	1	The Role of Fish in a Balanced Diet	2
	2	Omega-3 Fatty Acids and Health	2
	3	Vitamins and Minerals in Fish	2
	4	Safe Fish Consumption Identifying and mitigating risks: mercury, PCBs, and dioxins.	2
II	**Global Perspectives on Fish as Food**		**8**
	5	Fish in Traditional Diets Around the World	2
	6	Fish and Food Security	2
	7	Trends in Global Fish Consumption	2
	8	Challenges to Sustainable Fish Populations	2
III	**Fish Consumption: Nutrition, Health, and Global Food Systems**		**15**
	9	Comparative Nutritional Advantages of Fish	2
	10	Impact of processing and preservation on Nutrition	2
	11	Addressing Nutritional Deficiencies through Fish Consumption	2
	12	Sustainable Fish Consumption and Food Security	2
	13	Innovations in Aquaculture for Nutritional Security	2
	14	Challenges to Sustainable Fish Consumption	2
	15	The Role of Policy and Governance in Sustainable Fisheries	1
	16	Certification and Labeling for Sustainability	1
	17	Case Studies on Nutritional Interventions Involving Fish	1
IV	**Fish Quality, Safety, and Culinary Practices**		**6**
	18	Assessing Fish Quality and Freshness	2
	19	Food Safety Considerations in Fish Handling and Processing	1
	20	Cooking Fish: Methods and Nutrient Retention	1
	21	Innovative Seafood Products	1
	22	Developing a Sustainable Seafood Menu	1
V	**Open-Ended Module**		**8**
	1	Emerging Nutritional Research on Fish Innovations in Seafood Processing and Preservation Alternative and Plant-based Seafood Products: Fish and the Gut Microbiome Culinary Workshops and Demonstrations: Field Trips and Virtual Tours Panel discussion with experts	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	1	2	3	2	2	1	3	3	2
CO 2	2	2	2	3	1	3	3	2	2	1	3	3	2
CO 3	2	3	2	2	2	2	3	2	3	2	3	3	2
CO 4	3	2	3	2	2	3	2	2	3	2	3	3	3
CO 5	3	3	3	3	3	2	2	3	3	2	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓
CO 3	✓	✓		
CO 4	✓	✓		
CO 5		✓	✓	✓
CO 6		✓	✓	✓

1. "Fish Nutrition" by John E. Halver and Ronald W. Hardy
2. "Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C.
3. "Seafood and Aquaculture Marketing Handbook" by Carole R. Engle and Kwamena K. Quagrainie -
4. "Sustainable Diets: How Ecological Nutrition Can Transform Consumption and the Food System
5. "The Omega-3 Effect: Everything You Need to Know About the Supernutrient for Living Longer, Happier, and Healthier" by William Sears and James Sears

Programme	B. Sc. Aquaculture Honours					
Course Title	Marine biodiversity and conservation					
Type of Course	**MDC**					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	3	3		0	45	1 ½ hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course offers an in-depth look at marine ecosystems and conservation efforts, focusing on biodiversity threats and strategies for environmental protection and restoration.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Gain a comprehensive understanding of marine ecosystems, including their physical, chemical properties, and marine life forms.	U	C	Written exams, quizzes
CO2	Identify and analyze the major threats to marine biodiversity, including overfishing, pollution, habitat destruction, and climate change.	An	C	Case studies, project reports
CO3	Understand and apply principles of marine conservation, including the establishment and management of Marine Protected Areas (MPAs) and species-specific efforts.	Ap	P	Practical exams, lab reports
CO4	Evaluate the effectiveness of various marine conservation strategies, including habitat restoration, conservation biotechnology, and community-based efforts.	E	C	Research projects, presentations
CO5	Analyze the role of policy, governance, and international agreements in marine conservation, assessing their	An	F	Written exams, seminar presentations

	impacts through case studies.			
CO6	Design and implement a marine conservation project, employing appropriate research methods, data analysis, and communication of findings.	C	P	Group projects, lab practicals, reporting
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Marine Ecosystems**		**8**
	1	Overview of Marine Ecosystems	2
	2	Physical and Chemical Properties of Marine Environments	2
	3	Introduction to Marine Life Forms	2
	4	Ecological Roles and Food Web	2
II	**Threats to Marine Biodiversity**		**8**
	5	Overfishing and Fisheries Management	2
	6	Pollution and Its Impact on Marine Life	2
	7	Habitat Destruction and Alteration	2
	8	Climate Change Effects on Marine Ecosystems	2
III	**Marine Conservation Strategies**		**15**
	9	Principles of Marine Conservation	2
	10	Marine Protected Areas (MPAs)	2
	11	Species-Specific Conservation Efforts	2
	12	Habitat Restoration Techniques	2
	13	Conservation Biotechnology in Marine Biology	2
	14	Community-based Conservation Efforts	2
	15	International Conservation Agreements and Policies	1
	16	Conservation Education and Public Awareness	1
	17	Challenges and Future Directions in Marine Conservation	1
IV	**Policy and Governance in Marine Conservation**		**6**
	18	Overview of Marine Governance	2
	19	National Legislation and Policies	1
	20	International Frameworks and Agreements	1
	21	Role of NGOs and Civil Society	1
	22	Case Studies in Marine Policy Successes and Failures	1
V	**Open ended Module Research and Practical Application in Marine Conservation**		**8**
	1	• Introduction to Research Methods in Marine Biology • Designing a Marine Conservation Project • Data Collection and Analysis • Project Implementation • Reporting and Communication of Findings	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	2	2	1	2	3	2	2	2	3	3	2
CO 2	3	3	2	3	1	2	3	2	2	1	3	3	2
CO 3	3	3	3	3	2	2	3	3	3	1	3	3	3
CO 4	3	3	3	3	2	3	3	2	2	1	3	3	3
CO 5	2	2	3	3	3	3	2	3	3	2	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5		✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. "Marine Ecology: Processes, Systems, and Impacts" by Michel J. Kaiser et al.
2. "Oceanography and Marine Biology: An Introduction to Marine Science" by David W. Townsend -.
3. "Marine Conservation: Science, Policy, and Management" by G. Carleton Ray and Jerry McCormick-Ray.
4. "Aquatic Conservation: Marine and Freshwater Ecosystems" by John Wiley & Sons
5. "Marine Biology" by Peter Castro and Michael E. Huber.
6. "Marine Pollution" by R. B. Clark
7. "Marine Protected Areas for Whales, Dolphins, and Porpoises" by Erich Hoyt
8. "Introduction to the Biology of Marine Life" by John Morrissey and James L.

Skill Enhancement courses (SEC)

	Course code	Course title	Hours	Credit
1	AQC5FS112	Academic writing for life science students	**3**	**3**
2	AQC6FS113	Aquatic Specimen Preservation: Techniques and Practices for Museum Collections	**3**	**3**

Programme	B. Sc. Aquaculture Honours					
Course Title	Academic writing for life science students					
Type of Course	**SEC**					
Semester	V					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours	Exam duration
	3	3		0	45	1.5 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course teaches students how to write effectively and ethically in the life sciences, focusing on clarity, critical literature analysis, and preparing for academic publishing.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Master the principles of clear and effective academic writing tailored for the life sciences.	U	C	Quizzes, written exams
CO2	Understand and apply various scientific writing styles, focusing on passive vs. active voice and vocabulary precision.	Ap	C	Written exams, assignments
CO3	Develop skills in structuring scientific documents, including the use of the IMRaD format and logical argumentation.	Ap	P	Lab reports, project reports
CO4	Conduct comprehensive literature reviews, manage references effectively, and uphold academic integrity by avoiding plagiarism.	An	P	Research projects, presentations
CO5	Utilize advanced research and writing techniques for both qualitative and quantitative studies, tailored to specific audiences.	An	P	Case studies, seminar presentations
CO6	Navigate the academic publishing process, from literature search to understanding the ethics of writing and publication.	C	M	Group projects, peer review exercises
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Foundations of Academic Writing in Life Sciences**		**8**
	1	Introduction to Academic Writing - Principles of clear and effective writing; understanding the audience; purpose of academic writing in life sciences.	2
	2	Scientific Writing Style - Passive vs. active voice; using precise vocabulary; avoiding ambiguity and redundancy	2
	3	Structure of Scientific Documents - Overview of the IMRaD format; writing abstracts; structuring arguments logically.	2
	4	Basics of Scientific Research and Ethics	2
II	**Literature Review and Citation Practices**		**8**
	5	Conducting Literature Reviews - Identifying reliable sources; summarizing and synthesizing literature; gaps in the research.	2
	6	Citation Styles and Managing References - Overview of citation styles (APA, CSE); using reference management software	2
	7	Avoiding Plagiarism - Understanding plagiarism; paraphrasing vs. quoting; importance of academic integrity	2
	8	Critical Reading and Writing	2
III	**Advanced Research and Writing Techniques**		**15**
	9	Quantitative Research Writing - Describing methodologies; presenting and interpreting data; statistical analysis.	2
	10	Qualitative Research Writing - Narrative techniques; coding data; thematic analysis	2
	11	Writing for Specific Audiences - Tailoring content for academic vs. public audiences	2
	12	Policy briefs; Grant proposals	2
	13	Advanced Data Presentation - Using tables and figures effectively; visualization tools	1
	14	Strategies for self-editing; giving and receiving constructive feedback; peer review process	1
	15	Scientific articles for Newspapers and magazines	2
	16	Research journals, Types of research journals	2
	17	Research article, Components of a research articles	1
IV	**Mastering Academic Publishing: From Literature Search to Ethical Practices**		**6**
	18	Types of Literature search – use of library, books & journals –Pubmed , Science Direct, Scopus	2
	19	Publishing: submission of manuscript, Evaluation of research articles	1
	20	Ethics in writing, plagiarism, Falsification, Fabrication	1
	21	Predatory Journals, Pseudo-Journals, Pay-to-Publish Journals	1
	22	Peer reviewed journals and the Peer review process	1
V	**Open ended module**		**8**
	1	• Paraphrasing tools • Plagiarism checking software	

		• Impact of Artificial intelligence tools on academic writing • Writing workshop for students	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	2	2	3	2	2	1	3	2	2
CO 2	3	3	1	2	2	2	3	3	2	1	3	2	2
CO 3	3	3	2	3	2	2	3	3	3	1	3	2	3
CO 4	2	3	3	3	3	3	2	3	3	2	3	3	3
CO 5	2	2	3	2	3	3	2	2	3	3	2	3	3
CO 6	2	2	2	3	3	3	2	2	2	3	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. "The Craft of Scientific Writing" by Michael Alley –
2. "Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded" by Joshua Schimel -
3. "The Elements of Style" by William Strunk Jr. and E.B. White
4. "A Manual for Writers of Research Papers, Theses, and Dissertations" by Kate L. Turabian -
5. "Scientific Writing and Communication: Papers, Proposals, and Presentations" by Angelika H. Hofmann.
6. "Successful Scientific Writing: A Step-by-Step Guide for the Biological and Medical Sciences" by Janice R. Matthews and Robert W. Matthews.
7. "How to Write and Publish a Scientific Paper" by Barbara Gastel and Robert A. Day
8. "Doing a Literature Review in Health and Social Care: A Practical Guide" by Helen Aveyard

Programme	B. Sc. Aquaculture Honours
Course Title	Aquatic Specimen Preservation: Techniques and Practices for Museum Collections
Type of Course	**SEC**
Semester	VI
Academic Level	100-199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	3	3		0		1 ½ hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The course provides in-depth training in preserving aquatic specimens, combining traditional and advanced techniques with a focus on ethical practices and conservation. It prepares students for roles in museum curation and aquatic research.

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the fundamentals and importance of aquatic specimen preservation.	U	C	Written exams, quizzes
CO2	Apply basic principles of taxonomy and classification in the context of specimen preservation.	Ap	C	Practical exams, lab reports
CO3	Design educational and engaging museum displays incorporating modern technology.	C	P	Project reports, presentations
CO4	Master various chemical and physical preservation techniques for aquatic specimens.	Ap	P	Lab practicals, lab reports
CO5	Utilize advanced preservation techniques, including non-invasive imaging and digital preservation.	An	P	Research projects, group projects
CO6	Develop skills in specimen preparation, cataloging, and exhibition, adhering to ethical considerations.	C	P	Seminar presentations, museum visits

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit		Hrs
I	**Introduction to Aquatic Specimen Preservation**		**8**
	1	Overview of Aquatic Specimen Preservation	2
	2	History and Importance of Specimen Preservation in Museum	2
	3	Basic Principles of Taxonomy and Classification	2
	4	Ethical Considerations in Specimen Collection and Preservation	2
II	**Museum Display Techniques**		**8**
	5	Designing Educational and Engaging Displays	2
	6	Lighting and Climate Control for Aquatic Displays	2
	7	Interactive Displays: Incorporating Technology in Exhibits	2
	8	Maintenance of Live Aquatic Exhibits	2
III	**Techniques in Aquatic Specimen Preservation**		**15**
	9	Chemical Preservation Methods: Formalin, Alcohol, and Beyond	2
	10	Freeze-Drying and Cryopreservation Techniques	2
	11	Embedding Techniques: Plastics and Resins	2
	12	Skeleton Preparation: Cleaning and Assembly	2
	13	Tissue Sampling and DNA Preservation	2
	14	Photographic Documentation of Aquatic Specimens	2
	15	Creating Replicas: Molds and Casts	1
	16	Labeling and Cataloguing Specimens	1
	17	Storage and Long-term Care of Preserved Specimens	1
IV	**Advanced Preservation Techniques for Aquatic Specimens**		**6**
	18	Microscopic Techniques for Aquatic Organisms	2
	19	Anoxic Preservation Techniques	1
	20	3D Scanning and Digital Preservation	1
	21	Non-invasive Imaging Techniques	1
	22	Preservation of Large Aquatic Animals	1
V	**Open ended module**		**8**
	1	• Preparation of specimens • Visit to museums • Exhibition of prepared specimens	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	2	2	2	3	2	2	1	3	3	2
CO 2	3	3	2	2	2	1	3	2	3	2	3	2	2
CO 3	2	2	3	3	3	2	2	3	3	3	2	2	3
CO 4	3	3	2	3	3	3	3	2	3	2	3	3	3
CO 5	2	2	3	3	3	3	2	2	3	3	3	2	3
CO 6	3	3	3	3	3	3	3	3	3	2	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓		
CO 2	✓		✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓	✓	
CO 5		✓	✓	✓
CO 6	✓	✓		✓

Suggested reading

1. Biological Specimen Preparation for Transmission Electron Microscopy" by Audrey M. Glauert and Peter R. Lewis
2. "Fluid Preservation: A Comprehensive Reference" by John E. Simmons
3. "Natural History Collections: Past, Present, and Future" edited by John E. Simmons and Suzanne M. Butcher
4. "Museum Basics: The International Handbook" by Timothy Ambrose and Crispin Paine
5. "Conservation of Marine Archaeological Objects" by Colin Pearson
6. "Curating Biocultural Collections: A Handbook" edited by Jan Salick, Katie Konchar, and Mark Nesbitt
7. "Designing Exhibits for Kids: What Are We Thinking?" by Gail Ringel
8. "Digital Specimen Design: Preparing Biological Specimens for Digital Education" by Debra A. Linton and Lisa A. Lundgren

Value Added Courses for the Double main pathway

Programme	B. Sc. Aquaculture Honours					
Course Title	Ecotourism					
Type of Course	**VAC**					
Semester	III					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	3	3		0	45	1 ½ hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course on ecotourism in aquaculture focuses on imparting knowledge and skills in sustainable tourism practices, encompassing ecological, social, and economic aspects to promote conservation and community engagement.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Students will recall key concepts and principles of ecotourism, including environmental, social, and economic impacts.	Remember (R)	Factual Knowledge (F)	Written exams, Quizzes
CO2	Students will understand the integration of aquaculture in farm tourism and its significance to ecotourism.	Understand (U)	Conceptual Knowledge (C)	Case studies, Quizzes
CO3	Students will apply best practices for sustainable aquatourism, including waste management and pollution control.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, Lab reports
CO4	Students will analyze the effectiveness of different ecotourism strategies to enhance community engagement and environmental conservation.	Analyze (An)	Conceptual Knowledge (C)	Research projects, Group projects
CO5	Students will evaluate the challenges and opportunities in marine tourism, using tools such as eco-certification and crisis management	Evaluate (E)	Procedural Knowledge (P)	Seminar presentations, Project reports

	strategies.			
CO6	Students will create innovative designs for eco-friendly tourist facilities that incorporate advanced technologies and community-led initiatives.	Create (C)	Metacognitive Knowledge (M)	Design projects, Presentations
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Ecotourism**		**8**
	1	Foundations of Ecotourism	2
	2	Environmental Impacts	2
	3	Socio-economic Impacts	2
	4	Ethics and Best Practices	2
II	**Farm Tourism in Aquaculture**		**8**
	5	Introduction to farm tourism, its importance in aquaculture, and how it integrates with ecotourism.	2
	6	Management of Aquaculture Farms for Tourism	2
	7	Developing educational programs and tours that inform visitors about aquaculture processes and environmental stewardship	2
	8	Examination of successful farm tourism examples within the aquaculture industry.	2
III	**Aqua tourism**		**15**
	9	Exploration of aquatourism, including activities like snorkeling, scuba diving, and educational tours in aquatic settings	2
	10	Aquatic Biodiversity and Conservation	2
	11	Best practices for sustainable aquatourism, impact assessments, and methods to minimize the ecological footprint of tourism activities.	2
	12	Cultural and Community Engagement in Aquatourism	2
	13	Innovative conservation practices used in aquatourism to protect aquatic environments, such as coral reef restoration projects and artificial reefs.	2
	14	Eco-certification and Regulation Compliance	2
	15	Pollution Impacts by Aquatourism	1
	16	Managing Waste and Plastics in Aquatourism Environments	1
	17	Crisis Management and Resilience Building	1
IV	**Marine Tourism**		**6**
	18	Introduction to Marine Tourism	2
	19	Marine Protected Areas and Tourism	1
	20	Technologies in Marine Tourism	1
	21	Safety and Risk Management	1
	22	Marketing and Management	1
V	**Open ended Module Innovative Strategies and Community Engagement in Ecotourism**		**8**
		Innovative Design for Eco-Friendly Tourist Facilities Technology Integration in Ecotourism	

		Community-Led Ecotourism Development Restoration and Conservation Projects Future Challenges and Opportunities in Ecotourism	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	2	2	1	3	2	3	1	2	1	2
CO 2	1	2	2	3	1	1	2	3	2	2	3	1	1
CO 3	3	2	3	1	1	2	2	2	3	3	2	2	2
CO 4	2	2	3	2	3	1	1	2	1	3	1	2	3
CO 5	2	3	1	3	2	2	2	3	2	1	3	2	2
CO 6	1	2	2	2	2	3	1	1	3	2	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:Assignment,Seminar presentation,Internal exam,End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓			
CO 2		✓		
CO 3			✓	
CO 4				✓
CO 5		✓		
CO 6				

Suggested reading

1. "Ecotourism" by David A. Fennell
2. "Ecotourism and Sustainable Development: Who Owns Paradise?" by Martha Honey
3. The Business of Ecotourism" by Carol Patterson
4. "Tourism and Sustainability: Development, Globalisation and New Tourism in the Third World" by Martin Mowforth and Ian Munt
5. "Sustainable Tourism on a Finite Planet: Environmental, Business and Policy Solutions" by Megan Epler Wood

Programme	B. Sc. Aquaculture Honours					
Course Title	Environmental Impact Assessment					
Type of Course	**VAC**					
Semester	IV					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam duration
	3	3		0	45	1 ½ hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	he course "Fundamentals of Environmental Impact Assessment (EIA)" provides students with comprehensive knowledge and practical skills to understand, apply, and evaluate environmental impact assessment processes, focusing on aquatic ecosystems, mitigation strategies, and stakeholder engagement for sustainable development.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Recall EIA process components, methodologies, and techniques.	Remember (R)	Factual Knowledge (F)	Written exams, Quizzes
CO2	Understand EIA application in evaluating environmental impacts on aquatic ecosystems.	Understand (U)	Conceptual Knowledge (C)	Case studies, Quizzes
CO3	Apply EIA principles and methods to assess and mitigate impacts on aquatic ecosystems.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, Lab reports
CO4	Analyze SEAs' significance in evaluating long-term environmental effects on aquatic environments.	Analyze (An)	Conceptual Knowledge (C)	Research projects, Group projects
CO5	Evaluate mitigation strategies' effectiveness in minimizing impacts on aquatic ecosystems.	Evaluate (E)	Procedural Knowledge (P)	Seminar presentations, Project reports
CO6	Create innovative mitigation strategies,	Create (C)	Metacognitive Knowledge (M)	Design projects, Presentation

	incorporating stakeholder engagement for sustainable development.			
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Fundamentals of Environmental Impact Assessment (EIA)**		**8**
	1	Introduction to EIA	2
	2	EIA Process and Methodology	2
	3	Components of EIA	2
	4	Cumulative and strategic Environmental Assessment(SEA)	2
II	**Aquatic Ecosystems and Impacts**		**8**
	5	Understanding Aquatic Ecosystems	2
	6	Impact Assessment in Aquatic Environments	2
	7	Mitigation and Management Strategies	2
	8	Case Studies of Aquatic EIA	2
III	**Advanced Topics in Aquatic EIA**		**15**
	9	Deep-Sea Ecosystems	2
	10	Impacts of Offshore Development	2
	11	Coral Reef Assessment	2
	12	Cumulative Impact Models	2
	13	Assessing Water Pollution	2
	14	Fisheries Impact Assessment	2
	15	Public Participation in Marine EIA	1
	16	Socio-economic Considerations	1
	17	The role of public participation in the EIA process, particularly in sensitive aquatic environments	1
IV	**EIA Reporting and Post-EIA Activities**		**6**
	18	Preparing an EIA Report	2
	19	EIA Presentation Techniques	1
	20	Monitoring and Compliance	1
	21	EIA Audit and Evaluation	1
	22	Adaptive Management in EIA	1
V	**Open ended module Advanced Strategies in Environmental Impact Assessment"**		**8**
		Innovative Tools for EIA Scenario Planning and Future Forecasting Integrating Climate Change into EIA Stakeholder Engagement Strategi Unit 5: Creative Mitigation Strategies	

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	2	2	2	1	3	2	1	2	3	2	3
CO 2	2	3	2	2	2	1	2	3	3	2	2	3	2
CO 3	3	3	2	1	1	1	3	3	2	2	2	2	2
CO 4	2	2	3	2	3	1	2	2	2	2	2	3	3
CO 5	2	3	1	3	2	2	2	3	2	2	3	3	3
CO 6	1	2	2	2	2	3	3	3	3	3	3	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1			✓	✓
CO 2	✓	✓		
CO 3	✓		✓	
CO 4		✓		✓
CO 5		✓	✓	
CO 6				✓

Suggested reading

1. Environmental Impact Assessment: A Practical Guide" by Betty Bowers Marriott
2. Handbook of Environmental Impact Assessment (Volume 1 & 2)" edited by Judith Petts
3. "Methods of Environmental Impact Assessment" by Peter Morris and Riki Therivel
4. "Environmental Impact Assessment: Theory and Practice" by Anji Reddy Mareddy
5. Strategic Environmental Assessment in Action" by Riki Therivel
6. "Environmental and Social Impact Assessment" by Larry Cante

MINOR COURSES

Note-*Minor courses given below should not be offered to students who have taken Aquaculture as major Discipline. They should be offered to select from other Major Disciplines*

Group1 Aquaculture systems and Management

Programme	B. Sc. Aquaculture Honours					
Course Title	Introduction to Aquaculture					
Type of Course	**Minor Group1**					
Semester	I					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology					
Course Summary	This introductory course provides a broad overview of aquaculture, focusing on its principles, systems, management practices, and the sustainability challenges it faces. It is designed for students from various scientific backgrounds seeking foundational knowledge in aquaculture.					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the history and fundamental principles of aquaculture, including water quality, seed stock, and feed management.	Understand (U)	Conceptual Knowledge (C)	Written exams, Quizzes
CO2	Apply knowledge of various aquaculture systems and species-specific cultivation techniques for freshwater, marine, and ornamental species.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, Lab reports
CO3	Analyze nutritional requirements, feeding strategies, and health management practices to optimize aquaculture productivity and sustainability.	Analyze (An)	Procedural Knowledge (P)	Case studies, Project reports
CO4	Evaluate the environmental impacts of aquaculture practices and develop strategies to mitigate these impacts through sustainable practices.	Evaluate (E)	Conceptual Knowledge (C)	Research projects, Seminar presentations
CO5	Create and implement a mini aquaculture system project, demonstrating proficiency in practical aquaculture skills such as water quality management and disease prevention.	Create (C)	Procedural Knowledge (P)	Lab practicals, Group projects

CO6	Reflect on the role of aquaculture in societal and economic contexts, fostering a commitment to ethical practices and community engagement.	Evaluate (E)	Metacognitive Knowledge (M)	Presentations, Group discussions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs
I		**Introduction to Aquaculture**	**10**
	1	Definition and History of Aquaculture – Global and local perspectives. .	2
	2	Importance of Aquaculture – Contribution to food security and economic development	3
	3	Basic Principles of Aquaculture – Water quality, seed stock, and feed management	3
	4	Major Aquaculture Systems – Extensive, intensive, and super-intensive systems.	2
II		**Aquaculture Species and Cultivation Techniques**	**10**
	5	Freshwater Aquaculture – Key species and cultivation methods.	3
	6	Marine Aquaculture – Focus on marine fish, crustaceans, and shellfish	3
	7	Ornamental Fish Culture – Techniques and species popularity	2
	8	Algae and Aquatic Plant Cultivation – Uses in food, biofuel, and pharmaceuticals	2
III		**Nutrition, Health, and Disease Management**	**15**
	9	Nutritional requirements for various species.	2
	10	Feed types and feeding strategies	2
	11	Common diseases and parasites in aquaculture.	1
	12	Prevention and treatment of diseases.	2
	13	Biosecurity measures in aquaculture facilities.	2
	14	Vaccination and health management.	2
	15	Role of genetics in disease resistance.	1
	16	Stress management and its impact on health.	1
	17	Case studies on managing outbreaks in aquaculture settings.	2
IV	**Sustainability and Environmental Impact**		**10**
	18	Environmental Impacts of Aquaculture – Pollution and habitat destruction.	2
	19	Sustainable Practices – Strategies to mitigate environmental impacts	2
	20	Regulation and Policy – National and international frameworks.	2
	21	Innovations in Aquaculture – Recirculating systems, integrated multitrophic aquaculture	2
	22	Social Aspects – Community engagement and social responsibility.	2
V	**Practical Module**		**30**
		• Hands-on training in aquaculture facility operations.	

		• Water quality testing and management. • Seed stocking and harvesting techniques. • Feed preparation and feeding practices. • Disease identification and response actions. • Site visits to local aquaculture operations. • Workshop on aquaculture equipment use and maintenance. • Basic research methods in aquaculture studies. • Project on developing a mini aquaculture system. • Presentation of practical experiences and learning outcomes.	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	1	1	1	1	3	1	1	2	2	1	1
CO 2	3	3	2	2	2	2	2	2	3	1	3	1	2
CO 3	3	2	3	2	2	1	2	2	2	1	3	2	2
CO 4	2	2	2	3	2	2	3	2	2	1	3	3	3
CO 5	3	2	3	2	3	2	1	3	3	2	2	2	3
CO 6	1	1	2	3	1	1	2	3	1	2	1	3	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓
CO 4	✓	✓		✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓		✓

Suggested reading

1, Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C. Southgate

2,"Principles of Aquaculture" by Robert R. Stickney

3"Aquaculture Science" by Rick Parker

4,"Aquaculture: Principles and Practices" by T.V.R. Pillay and M.N. Kutty

5, Recirculating Aquaculture" by Michael B. Timmons and James M. Ebeling

6, Aquaponics Food Production Systems" edited by Simon Goddek et al.

7,"Disease in Aquaculture: Prevention and Control" by Malcolm Jobling

8"Sustainable Aquaculture Techniques" edited by Martha Patricia Hernandez-Vergara and Carlos Ivan Perez-Rostro

9, Nutrition and Feeding of Fish and Crustaceans" by Jean Guillaume, Sadasivam J. Kaushik, and Pierre Bergo

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquaculture Disease Management					
Type of Course	**Minor Group1**					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	Aquaculture Disease Management introduces principles and practices for preventing, diagnosing, and controlling diseases in aquaculture, covering disease biology, epidemiology, diagnostics, treatment, and prevention strategies with a focus on practical applications and case studies.					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of aquaculture health management.	Understand (U)	Conceptual Knowledge (C)	Written exams, quizzes, case studies
CO2	Identify common pathogens in aquaculture systems and their transmission routes.	Remember (R)	Factual Knowledge (F)	Written exams, quizzes, lab practicals
CO3	Analyze the impact of diseases on aquaculture production.	Analyze (An)	Conceptual Knowledge (C)	Written exams, case studies, research projects
CO4	Apply diagnostic techniques and surveillance methods in aquaculture disease management.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, lab reports, field visits
CO5	Evaluate different treatment and control measures for aquaculture diseases.	Evaluate (E)	Conceptual Knowledge (C)	Written exams, presentations, research projects
CO6	Demonstrate practical skills in disease monitoring, diagnosis, and management in aquaculture settings.	Apply (Ap)	Procedural Knowledge (P)	Lab practicals, practical exams, field visits

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Aquaculture Diseases**		**10**

	1	Overview of Aquaculture Health Management	2
	2	Common Pathogens in Aquaculture Systems	3
	3	Disease Transmission Routes in Aquatic Environments	3
	4	Impact of Diseases on Aquaculture Production	2
II	**Disease Diagnosis and Surveillance**		**10**
	5	Diagnostic Techniques in Aquaculture	3
	6	Sampling Methods and Data Analysis	3
	7	Epidemiology and Disease Surveillance	2
	8	Biosecurity Measures and Disease Prevention	2
III	**Pathogens and Diseases in Aquatic Organisms**		**15**
	9	Bacterial Diseases in Aquaculture	2
	10	Viral Diseases in Aquatic Species	2
	11	Parasitic Infections and Management	1
	12	Fungal Diseases in Aquatic Environments	2
	13	Protozoan Diseases in Aquatic Organisms	2
	14	Environmental Stressors and Disease Susceptibility	2
	15	Immunology and Disease Resistance in Aquatic Species	1
	16	Emerging Diseases in Aquaculture	1
	17	Case Studies on Disease Outbreaks and Management Strategies	2
IV	**Disease Treatment and Control**		**10**
	18	Chemotherapy and Pharmacology in Aquaculture	2
	19	Vaccination Strategies and Immunoprophylaxis	2
	20	Prophylactic Measures and Disease Prevention	2
	21	Quarantine Procedures and Biosecurity Protocols	2
	22	Integrated Disease Management Approaches	2
V	**Practical Module**		**30**
		1. Disease Monitoring in Aquaculture Facilities 2. Diagnostic Techniques Practicum 3. Treatment Administration and Management 4. Biosecurity Assessment and Implementation 5. Field Visits to Aquaculture Operations 6. Case Study Analysis and Presentations 7. Practical Exercises in Disease Management 8. Research Project on Aquaculture Disease 9. Final Practical Examination 10. Reflection and Discussion on Practical Experiences	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

CO-PO and CO-PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	3	2	2	2	3	2	1	3	3	2
CO 2	3	3	1	3	2	2	3	2	2	2	3	3	2
CO 3	3	2	1	3	2	3	3	2	2	1	3	3	3
CO 4	2	2	1	3	2	3	2	3	3	2	3	3	3
CO 5	2	2	1	3	3	3	2	2	2	2	3	3	3
CO 6	2	2	1	3	3	3	2	3	3	2	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. Aquaculture Medicine by E.V. Millar and J.P. Hawke
2. Fish Diseases: Prevention and Control Strategies by Galina Jeney
3. Aquatic Animal Health Code published by the World Organisation for Animal Health
4. Fish Disease: Diagnosis and Treatment by Edward J. Noga
5. Handbook of Salmon Farming by Dr. Selina M. Stead and Dr. Paul A. Hart
6. Aquaculture and Fisheries Biotechnology: Genetic Approaches by Rex A. Dunham

Programme	B. Sc. Aquaculture Honours					
Course Title	Aquaculture Production Systems					
Type of Course	**Minor Group1**					
Semester	III					
Academic Level	200-299					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	Aquaculture Production Systems covers diverse techniques like pond culture, cage culture, RAS, and IMTA, emphasizing principles, management, environmental factors, and practical					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of aquaculture production systems.	Understand (U)	Conceptual Knowledge (C)	Written exams, quizzes, case studies
CO2	Identify key environmental factors influencing aquaculture and apply sustainable practices.	Apply (Ap)	Conceptual Knowledge (C), Procedural Knowledge (P)	Practical exams, field reports, case studies
CO3	Analyze the management strategies and techniques employed in pond and cage culture systems.	Analyze (An)	Procedural Knowledge (P)	Lab reports, case studies, project reports
CO4	Evaluate the design, operation, and management of recirculating aquaculture systems (RAS).	Evaluate (E)	Procedural Knowledge (P), Conceptual Knowledge (C)	Research projects, presentations, practical exams
CO5	Assess the concepts, benefits, and challenges of integrated multi-trophic aquaculture (IMTA).	Evaluate (E)	Conceptual Knowledge (C), Analytical Knowledge (An)	Presentations, research projects, case studies
CO6	Demonstrate practical skills in various aquaculture production techniques and technologies.	Apply (Ap)	Procedural Knowledge (P)	Lab practicals, field visits, final practical examination
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs
I	**Introduction to Aquaculture Production**		**10**
	1	Overview of Aquaculture Systems	2
	2	Principles of Aquaculture Production	3
	3	Environmental Factors Influencing Aquaculture	3
	4	Sustainable Practices in Aquaculture Productio	2
II	**Pond and Cage Culture**		**10**
	5	Pond Culture Systems and Management	3
	6	Cage Culture Systems and Operations	3
	7	Stocking, Feeding, and Water Quality Management in Pond and Cage Culture	2
	8	Disease Management and Biosecurity in Pond and Cage Culture	2
III	**Recirculating Aquaculture Systems (RAS)**		**15**
	9	Introduction to RAS Technology	2
	10	Design and Components of RAS	2
	11	Water Quality Management in RAS	1
	12	Fish Health and Biosecurity in RAS	2
	13	Feeding and Nutrition in RAS	2
	14	RAS Production of Finfish Species	2
	15	RAS Production of Shellfish Species	1
	16	Economics and Sustainability of RAS	1
	17	Case Studies and Practical Applications of RAS	2
IV	**Integrated Multi-Trophic Aquaculture (IMTA)**		**10**
	18	Concepts and Principles of IMTA	2
	19	Species Selection and Integration in IMTA Systems	2
	20	Nutrient Dynamics and Bioremediation in IMTA	2
	21	Environmental Benefits and Challenges of IMTA	2
	22	Implementation and Management of IMTA Projects	2
V	**Practical Module**		**30**
		1. Hands-on Experience in Pond Culture Operations 2. Cage Culture Setup and Management Practices 3. Practical Training in RAS Operation and Maintenance 4. Field Visits to IMTA Facilities 5. Case Studies and Group Projects on Aquaculture Production Systems 6. Research Project on Innovative Aquaculture Production Techniques 7. Final Practical Examination 8. Data Collection and Analysis for Aquaculture Production Systems 9. Report Writing and Presentation of Practical Findings 10. Reflection and Discussion on Practical Experiences	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four module

CO-PO and CO-PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	3	2	2	2	3	2	1	3	3	2
CO 2	2	2	1	3	3	3	3	3	2	2	3	3	3
CO 3	2	2	1	3	2	2	2	2	2	2	3	2	2
CO 4	2	2	1	3	3	3	3	2	2	2	3	3	3
CO 5	2	2	1	3	3	3	2	2	2	2	3	3	3
CO 6	2	3	1	3	3	3	2	3	3	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6	✓	✓	✓	✓

Suggested reading

1. Aquaculture: Farming Aquatic Animals and Plants by John S. Lucas and Paul C. Southgate
2. Sustainable Aquaculture by John Hargreaves
3. Aquaculture Engineering by Odd-Ivar Lekang
4. Recirculating Aquaculture by Michael B. Timmons and James M. Ebeling
5. Cage Aquaculture by Malcolm C.M. Beveridge and Bruce Phillips
6. Integrated Multi-Trophic Aquaculture edited by Øivind Strand and Richard S. Telfer
7. Aquaculture Pond Fertilization: Impacts of Nutrient Input on Production (author not provided)
8. Aquaponics: Integration of Hydroponics with Aquaculture by Rakocy J.E., Bailey D.S., and Shultz R.C.

Group 2 ***Seafood Safety and Trade***

Programme	B. Sc. Aquaculture					
Course Title	Introduction to Seafood Quality Control					
Type of Course	**Minor Group2**					
Semester	1					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3		2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology.					
Course Summary	This course provides comprehensive training in seafood quality control, covering essential aspects such as quality assessment techniques, preservation methods, safety regulations, and practical skills in ensuring seafood quality and safety standards.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the basics of seafood quality, including key factors and types of spoilage.	U	F	Quizzes, written assignments, and class participation.
CO2	Apply sensory evaluation, chemical analysis, and microbiological testing techniques in quality assessment.	Ap	P	Practical lab sessions, hands-on training, and lab reports.
CO3	Analyze various seafood preservation and processing methods and their impact on quality.	An	C	Written exams, case study analyses, and group discussions.
CO4	Evaluate safety and regulatory compliance measures, including HACCP and food safety systems.	E	C	Written assignments, compliance exercises, and regulatory case study evaluations.
CO5	Create a quality control plan for seafood processing, incorporating modern technologies.	C	P	Project work, practical demonstrations, and presentations.
CO6	Develop practical skills in packaging, storage techniques, and real-	C	P	Practical exercises, industry visits, and workshops.

	world case studies.			
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Basics of Seafood Quality Control**		**10**
	1	Overview of seafood quality, importance, and key factors.	2
	2	Physical, chemical, and biological parameters	3
	3	Types of spoilage, contamination sources, and preventive measures.	3
	4	National and international seafood quality standards.	2
II	**Techniques in Seafood Quality Assessment**		**10**
	5	Sensory Evaluation	3
	6	Chemical Analysis	3
	7	Microbiological Testing	2
	8	Modern techniques and technologies in quality assessment.	2
III	**Preservation and Processing Methods**		**15**
	9	Introduction to Preservation Methods	2
	10	Freezing and Chilling	2
	11	Canning and Smoking	2
	12	Drying and Salting	1
	13	Emerging Preservation Techniques	1
	14	Impact of Processing on Quality	1
	15	Packaging and Storage	2
	16	Quality Control in Processing	2
	17	Case Studies and Industry Practices	2
IV	**Safety and Regulatory Compliance**		**10**
	18	Introduction to HACCP and other food safety systems.	2
	19	Overview of relevant seafood safety regulations.	2
	20	Compliance and Certification	2
	21	Methods and importance of inspection and auditing.	2
	22	Consumer rights, protection, and ethical considerations.	2
V	**Practical module**		**30**
	1	Hands-on training in sensory evaluation techniques. Laboratory exercises on chemical testing methods Practical sessions on microbial analysis. Demonstrations and practice of various preservation methods. Implementing quality control during processing. Exercises on regulatory compliance and certification. Hands-on experience in packaging and storage techniques. Practical analysis of real-world case studies.	
	2	Visits to seafood processing units and workshops on best practices.	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	2	2	1	3	3	1	2	1	2	2	1
CO 2	3	2	3	3	2	3	2	2	2	2	3	2	1
CO 3	3	3	3	3	2	3	3	2	2	2	3	2	1
CO 4	2	2	2	3	2	3	2	1	2	1	3	3	1
CO 5	3	2	3	3	3	3	2	3	3	2	3	3	3
CO 6	3	3	3	3	3	3	2	3	3	3	3	3	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		
CO 3		✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓		✓	✓
CO 6		✓		

1. "Seafood Quality and Safety: Advances in the Understanding of Seafood Quality" by Fereidoon Shahidi
2. "Handbook of Seafood and Seafood Products Analysis" by Leo M.L. Nollet and Fidel Toldrá
3. "Quality Assurance in Seafood Processing: A Practical Guide" by Kenji Murakami
4. Seafood Processing: Technology, Quality and Safety" by Ioannis S. Boziaris
5. "Food Safety Management: A Practical Guide for the Food Industry" by Yasmine Motarjemi and Huub Lelieveld
6. "Preservation of Fish and Meat" by John Ryder, Ian Karunasagar, and Richard S. Morris

Programme	B. Sc. Aquaculture					
Course Title	Fundamentals of Seafood Trade					
Type of Course	**Minor Group2**					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3		2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology. Should have completed previous semesters					
Course Summary	This course provides an in-depth understanding of seafood trade and inspection, focusing on global and Indian trade dynamics, regulations, quality control, logistics, and practical skills for managing export and import processes					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the global seafood industry, including key players, markets, and economic impacts.	U	F	Quizzes, written assignments, and class participation.
CO2	Explain the international and national seafood trade regulations, including certification schemes.	U	C	Written exams, presentations, and group discussions.
CO3	Describe the export and import processes specific to the Indian seafood industry.	U	F	Written exams, assignments, and case study analyses.
CO4	Apply knowledge of trade logistics, including cold chain management and packaging standards.	Ap	P	Practical exercises, lab sessions, and field visit reports.
CO5	Analyze the challenges and opportunities in the Indian seafood export industry.	An	C	Written assignments, case studies, and group discussions.
CO6	Develop practical skills in preparing trade	C	P	Practical sessions, project work, and

	documentation, ensuring compliance, and managing risks.			presentations.
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Seafood Trade**		**10**
	1	An introduction to the global seafood industry, key players, and major markets	2
	2	The economic impact of seafood trade on global and local economies.	3
	3	Understanding the seafood supply chain from harvest to market.	3
	4	Overview of international trade policies and agreements affecting seafood trade.	2
II	**Seafood Trade Regulations**		**10**
	5	Key international regulations governing seafood trade (WTO, Codex Alimentarius)	3
	6	Seafood trade regulations specific to various countries.	3
	7	Certification schemes and standards (MSC, ASC, etc.) in the seafood industry.	2
	8	Procedures and documentation required for exporting and importing seafood.	2
III	**Export and Import of Seafood Trade in India**		**15**
	9	Introduction to the Indian seafood industry and its significance in global trade.	2
	10	Key seafood products exported from India.	2
	11	Major international markets for Indian seafood.	2
	12	Key seafood products imported into India and their sources.	1
	13	Indian regulatory bodies overseeing seafood trade (MPEDA, FSSAI).	1
	14	Essential documentation and procedures for exporting seafood from India.	1
	15	Regulations and procedures for importing seafood into India	2
	16	Quality standards and certifications required for exporting Indian seafood.	2
	17	Challenges faced by the Indian seafood export industry and potential opportunities.	2
IV	**Market Access and Trade Logistics**		**10**
	18	Market Access Requirements	2
	19	Logistics involved in the global seafood supply chain.	2
	20	Importance and management of the cold chain in seafood trade.	2
	21	Packaging and labeling standards for international trade.	2
	22	Identifying and overcoming trade barriers in the seafood industry.	2
V	**Practical Module**		**30**
	1	Export Documentation Preparation Import Documentation Preparation Trade Compliance and Regulations Market Access Requirements	

		Cold Chain Management Packaging and Labeling Quality Control in Trade Trade Barrier Analysis Risk Assessment in Trade	
	2	**Field Visits**	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	2	2	1	3	3	1	2	1	2	1	1
CO 2	3	2	2	2	1	3	3	2	2	1	3	2	1
CO 3	2	3	2	2	2	3	2	1	2	1	2	1	-
CO 4	3	3	3	2	2	3	2	2	2	2	3	2	1
CO 5	3	2	3	3	3	3	2	1	2	2	3	2	1
CO 6	3	2	3	3	3	3	2	2	3	2	3	2	2

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examinatio

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		
CO 3		✓	✓	✓

CO 4	✓	✓	✓	✓
CO 5	✓		✓	✓
CO 6		✓		

Suggested reading

1. "Seafood and Aquaculture Marketing Handbook" by Carole R. Engle
2. "Seafood Supply Chain Management: From a Business Perspective" by P.J. Bechtel, C.O. Love
3. "Fishery Products: Quality, Safety, and Authenticity" edited by Hartmut Rehbein and Jörg Oehlenschläger
4. "Global Fishery Resources: Their Management and Economic Implications" by Hiroshi Kasahara
5. "Export/Import Procedures and Documentation" by Thomas E. Johnson
6. "Seafood Safety, Processing, and Biotechnology" by Fereidoon Shahidi, Yvonne M. Jones

Programme	B. Sc. Aquaculture					
Course Title	Seafood quality management systems					
Type of Course	**Minor Group2**					
Semester	III					
Academic Level	200-299					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3		2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology. Should have completed previous semesters					
Course Summary	This course offers an in-depth exploration of seafood quality management systems, focusing on regulatory standards, quality control techniques, and practical implementations within the seafood industry to ensure product safety and compliance.					

CO	CO Statement	Cognitive Level*	Knowledge Category	Evaluation Tools used
CO1	Understand the key attributes and factors affecting seafood quality.	U	F	Quizzes, written assignments, and class participation.
CO2	Explain the principles and implementation of various quality management systems in seafood processing.	U	C	Written exams, presentations, and group discussions.
CO3	Describe the regulatory frameworks and standards governing seafood quality management.	U	F	Written exams, assignments, and case study analyses.
CO4	Apply quality management techniques, including HACCP, GMPs, and SSOPs, in seafood processing.	Ap	P	Practical exercises, lab sessions, and field visit reports.
CO5	Analyze the challenges and best	An	C	Written assignments, case studies, and

	practices in maintaining seafood quality and compliance.			group discussions.
CO6	Develop practical skills in implementing and auditing quality management systems.	C	P	Practical sessions, project work, and presentations.
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit		Hrs
I	**Introduction to Seafood Quality Management Systems**		**10**
	1	Overview of Seafood Quality Management	2
	2	Key physical, chemical, and sensory attributes affecting seafood quality.	3
	3	Biological, environmental, and processing factors impacting seafood quality.	3
	4	Basics of QMS and their role in maintaining seafood quality.	2
II	**Regulatory Frameworks and Standards**		**10**
	5	HACCP (Hazard Analysis Critical Control Point)	3
	6	ISO 22000: Food Safety Management Systems	3
	7	FSSAI Guidelines	2
	8	EU Regulations and USFDA Standards	2
III	**Quality Management Techniques and Systems**		**15**
	9	Principles of TQM and its application in the seafood industry	2
	10	Implementation of GMPs to ensure seafood safety and quality.	2
	11	Importance and development of SSOPs in seafood processing.	2
	12	Techniques for quality control and assurance in seafood processing.	1
	13	Methods and importance of inspection and auditing in maintaining seafood quality.	1
	14	Ensuring traceability of seafood products through the supply chain.	1
	15	Identifying and managing risks in seafood quality management.	2
	16	Best practices for documentation and record keeping in quality management systems.	2
	17	Strategies for continuous improvement in seafood quality management.	2
IV	**Certification and Compliance**		**10**
	18	Certification Schemes	2
	19	Compliance with National and International Standards	2
	20	Third-Party Audits and Inspections	2
	21	Ethical and Sustainable Practices	2
	22	Analysis of real-world case studies on seafood quality management and compliance	2
V	**Practical Module**		**30**
	1	Practical exercises on developing and implementing HACCP plans in seafood processing	

		Hands-on training on meeting ISO 22000 standards in seafood operations. Practical application of FSSAI guidelines in seafood quality management. Exercises on ensuring compliance with EU and USFDA regulations. Implementing Total Quality Management practices in seafood processing. Developing and applying Good Manufacturing Practices and Sanitation Standard Operating Procedures. Hands-on training in quality control techniques and tools. Practical exercises in conducting inspections and audits for quality assurance. Practical exercises in maintaining documentation and records.	
	2	Visits to seafood processing units to observe quality management systems in action.	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	2	2	1	3	3	1	2	1	2	2	1
CO 2	3	2	2	2	1	3	3	2	2	1	3	2	1
CO 3	2	3	2	2	2	3	2	1	2	1	2	2	-
CO 4	3	3	3	2	2	3	2	2	2	2	3	2	1
CO 5	3	2	3	3	3	3	2	1	2	2	3	2	1
CO 6	3	2	3	3	3	3	2	2	3	2	3	2	2

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examinatio

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		
CO 3		✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓		✓	✓
CO 6		✓		

1. "Seafood and Aquaculture Marketing Handbook" by Carole R. Engle
2. Seafood Processing: Technology, Quality and Safety" by Ioannis S. Boziaris
3. "HACCP: A Practical Approach" by Sara Mortimore and Carol Wallace
4. "Food Safety Culture: Creating a Behavior-Based Food Safety Management System" by Frank Yiannas
5. "Quality Assurance for the Food Industry: A Practical Approach" by J. Andres Vasconcellos
6. Guide to Food Safety and Quality During Transportation: Controls, Standards and Practices" by John M. Ryan
7. "Regulatory Foundations for the Food Protection Professional" by David Acheson and Hal King

Vocational Minor Courses

Applied Fisheries

Note- ***Vocational Minor courses given below should not be offered to students who have taken Aquaculture as major Discipline. They should be offered to select from other Major Disciplines***

Group 1 Commercial Production of Ornamental fishes

Programme	B. Sc. Aquaculture Honours					
Course Title	Ornamental Fish Breeding Techniques					
Type of Course	**Vocational Minor (Group1)**					
Semester	I					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology					
Course Summary	The Ornamental Fish Breeding Techniques course offers a comprehensive study of breeding methods, management strategies, and practical applications essential for successful ornamental fish production					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the overview of the ornamental fish industry.	U	Conceptual Knowledge (C)	Written exams, quizzes, presentations
CO2	Recognize the importance of breeding techniques in the ornamental fish trade.	U	Conceptual Knowledge (C)	Written exams, quizzes, presentations
CO3	Demonstrate the ability to select and manage broodstock for ornamental fish breeding.	Ap	Procedural Knowledge (P)	Practical exams, lab reports, case studies
CO4	Apply facility design principles for setting up ornamental fish breeding operations.	Ap	Procedural Knowledge (P)	Practical exams, lab reports, case studies
CO5	Implement spawning induction techniques and larval rearing strategies.	Ap	Procedural Knowledge (P)	Practical exams, lab reports, case studies
CO6	Evaluate disease management protocols and marketing strategies in ornamental fish breeding.	An	Procedural Knowledge (P)	Practical exams, lab reports, case studies
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs
I	**Introduction to Ornamental Fish Breeding**		**10**
	1	Overview of the Ornamental Fish Industry	2
	2	Importance of Breeding Techniques in Ornamental Fish Trade	3
	3	Broodstock Selection and Management	3
	4	Facility Design and Set-up for Ornamental Fish Breeding	2
II	**Spawning Induction and Larval Rearing**		**10**
	5	Hormonal Manipulation Techniques for Spawning Induction	3
	6	Spawning Behavior and Egg Collection	3
	7	Larval Rearing Techniques and Feeding Strategies	2
	8	Water Quality Parameters for Larval Rearing	2
III	**Disease Management in Ornamental Fish Breeding**		**15**
	9	Common Diseases in Ornamental Fish Breeding	2
	10	Prevention and Control Measures for Diseases	2
	11	Quarantine Protocols for Broodstock and Fry	1
	12	Medication and Treatment Methods	2
	13	Biosecurity Practices in Ornamental Fish Facilities	2
	14	Health Monitoring and Disease Surveillance	2
	15	Nutritional Requirements for Broodstock and Fry	1
	16	Stress Management Techniques	1
	17	Emergency Response Plans for Disease Outbreaks	2
IV	**Marketing and Business Strategies**		**10**
	18	Market Trends and Demand Analysis in Ornamental Fish Trade	2
	19	: Branding and Product Differentiation	2
	20	Pricing Strategies for Ornamental Fish	2
	21	Sales Channels and Distribution Networks	2
	22	Customer Relationship Management and After-sales Service	2
V	**Practical Module**		**30**
		1. Hands-on Experience in Spawning Induction Techniques 2. Larval Rearing Practicum 3. Disease Management Simulation 4. Water Quality Assessment in Breeding Facilities 5. Facility Design Project 6. Marketing Plan Development 7. Field Visits to Ornamental Fish Hatcheries 8. Case Studies and Group Projects	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	1	1	1	1	2	3	1	1	2	2	1
CO 2	2	2	1	1	1	1	2	3	1	1	2	2	1
CO 3	2	2	2	1	1	1	2	2	2	2	2	2	1
CO 4	2	2	2	1	1	1	2	2	2	2	2	2	1
CO 5	2	2	2	1	1	1	2	2	2	2	2	2	1
CO 6	2	2	2	1	1	1	2	2	2	2	2	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4			✓	✓
CO 5			✓	✓
CO 6			✓	✓

Suggested reading

1. Breeding Aquarium Fishes: A Complete Introduction" by Herbert R. Axelrod and Warren E. Burgess
2. "Ornamental Fish Farming: Principles and Practices" by R.S.V. Pullin, M.S. Fitzsimmons, and C.S. Tucker
3. The Aquarium Fish Handbook" by David Goodwin
4. Handbook of Fish Diseases" by Dieter Untergasser
5. Aquaculture Principles and Practices: Fishing News Books" by T.V.R. Pillay
6. "Ornamental Fish Breeding" by A.G. Jones –
7. Fish Physiology: The Physiology of Tropical Fishes" edited by Adalberto Luis Val and Vera Maria Fonseca de Almeida e Val
8. "Successful Fish Breeding" by Stephen Spotte

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Programme	B. Sc. Aquaculture Honours					
Course Title	Aquarium Systems and Management					
Type of Course	**Vocational Minor**					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The suggested readings provide comprehensive insights into aquarium systems and management, covering topics such as freshwater and saltwater aquarium setups, aquatic plant care, reef ecosystems, and coral reef management.					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the structure and dynamics of the aquarium industry.	U	Conceptual Knowledge (C)	Written exams, quizzes, presentations
CO2	Apply principles of aquarium design to create functional and aesthetically pleasing aquariums.	Ap	Procedural Knowledge (P)	Practical exams, project reports, presentations
CO3	Demonstrate the ability to select appropriate equipment and install aquarium systems effectively.	Ap	Procedural Knowledge (P)	Practical exams, lab reports, presentations
CO4	Analyze and implement aquascaping techniques to enhance the visual appeal of aquariums.	An	Procedural Knowledge (P)	Lab reports, case studies, presentations
CO5	Identify key water parameters and their significance in maintaining water quality in aquariums.	U	Factual Knowledge (F)	Written exams, quizzes, practical exams
CO6	Apply various filtration systems and techniques to maintain optimal water quality in aquariums.	Ap	Procedural Knowledge (P)	Practical exams, lab reports, project reports

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Aquarium Systems**		**10**
	1	Overview of Aquarium Industry	2
	2	Principles of Aquarium Design	3
	3	Equipment Selection and Installation	3
	4	Aquascaping and Aesthetic Considerations	2
II	**Water Quality Management**		**10**
	5	Understanding Water Parameters	3
	6	Filtration Systems and Techniques	3
	7	Nitrogen Cycle and Biological Filtration	2
	8	Water Testing and Maintenance Procedures	2
III	**Aquatic Species Selection and Husbandry**		**15**
	9	Freshwater and Marine Species Selection	2
	10	Fish and Invertebrate Compatibility	2
	11	Feeding and Nutrition Requirements	1
	12	Behavior and Social Dynamics in Aquariums	2
	13	Breeding and Reproduction in Captivity	2
	14	Handling and Acclimation Techniques	2
	15	Disease Prevention and Management	1
	16	Environmental Enrichment and Welfare	1
	17	Legal and Ethical Considerations in Species Management	2
IV	**Aquarium Maintenance and Troubleshooting**		**10**
	18	Routine Maintenance Procedures	2
	19	Algae Control Strategies	2
	20	Common Problems and Troubleshooting	2
	21	Emergency Preparedness and Response	2
	22	Equipment Maintenance and Repair	2
V	**Practical Module**		**30**
		1. Aquarium Setup and Aquascaping Practicum 2. Water Quality Testing and Filtration System Maintenance 3. Species Handling and Feeding Techniques 4. Disease Management and Quarantine Protocols 5. Aquatic Plant Care and Maintenance 6. Aquarium Design Project 7. Field Visits to Aquarium Facilities 8. Case Studies and Group Projects	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four module

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	2	1	1	1	3	2	1	1	2	2	1
CO 2	3	3	2	1	2	1	2	3	2	1	2	1	2
CO 3	2	2	2	1	2	1	2	3	2	1	2	1	1
CO 4	2	1	2	1	2	1	1	2	2	1	2	1	1
CO 5	2	2	1	1	2	1	2	1	2	3	2	1	1
CO 6	2	2	2	2	2	2	2	2	3	2	2	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3		✓	✓	✓
CO 4	✓	✓		✓
CO 5	✓		✓	✓
CO 6		✓	✓	✓

Suggested reading

1. Aquarium Plants" by Christel Kasselmann –
2. The Simple Guide to Freshwater Aquariums" by David E. Boruchowitz
3. "Saltwater Aquariums For Dummies" by Gregory Skomal
4. "Ecology of the Planted Aquarium: A Practical Manual and Scientific Treatise" by Diana Walstad
5. The Reef Aquarium, Vol. 3: Science, Art, and Technology" by Julian Sprung and J. Charles Delbeek
6. "Aquarium Corals: Selection, Husbandry, and Natural History" by Eric H. Borneman

Programme	B. Sc. Aquaculture Honours
Course Title	Health Management in Ornamental Fish
Type of Course	**Vocational Minor(Group1)**
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	"Health Management in Ornamental Fish provides a comprehensive understanding of disease prevention, diagnosis, and treatment, alongside essential practices in water quality management and biosecurity measures crucial for ensuring the well-being of ornamental fish populations in aquariums and aquaculture facilities."

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of health management in ornamental fish.	U	Conceptual Knowledge (C)	Written exams, quizzes, case studies
CO2	Recognize the importance of disease prevention in ornamental fish and its impact on populations.	U	Conceptual Knowledge (C)	Written exams, quizzes, case studies
CO3	Identify the basic anatomy and physiology of ornamental fish.	U	Conceptual Knowledge (C)	Written exams, practical exams, lab reports
CO4	Explain the principles and importance of biosecurity measures in ornamental fish facilities.	U	Conceptual Knowledge (C)	Written exams, quizzes, case studies
CO5	Apply diagnostic techniques for identifying common fish diseases	Ap	Procedural Knowledge (P)	Practical exams, lab practicals, field

	and water quality analysis.			observations
CO6	Develop and implement prevention strategies, quarantine procedures, and integrated pest management approaches in ornamental fish facilities.	Ap	Procedural Knowledge (P)	Case studies, group projects, practical exercise

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Health Management in Ornamental Fish**		**10**
	1	Overview of health management principles	2
	2	Importance of disease prevention in ornamental fish	3
	3	Basic anatomy and physiology of ornamental fish	3
	4	Introduction to biosecurity measures	2
II	**Common Diseases in Ornamental Fish**		**10**
	5	Identification and classification of common fish diseases	3
	6	Symptoms, causes, and transmission routes of diseases	3
	7	Case studies and examples of disease outbreaks	2
	8	Impact of diseases on ornamental fish populations	2
III	**Disease Diagnosis and Treatment**		**15**
	9	Diagnostic Techniques in Ornamental Fish Health Management	2
	10	Water Quality Analysis and Its Role in Disease Diagnosis	2
	11	Understanding Fish Pathogens: Bacteria, Viruses, and Parasite	1
	12	Treatment Options: Medications and Antibiotics	2
	13	Alternative Therapies in Ornamental Fish Health Management	2
	14	Diagnosis and management of bacterial diseases	2
	15	Diagnosis and management of viral diseases	1
	16	Alternative Therapies in Ornamental Fish Health Management	1
	17	Surgical Interventions in Fish Health Management	2
IV	**Prevention Strategies and Biosecurity Measures**		**10**
	18	Biosecurity protocols for ornamental fish facilities	2
	19	Quarantine procedures for new fish arrivals	2
	20	Environmental management for disease prevention	2
	21	Integrated pest management approaches	2
	22	Risk Assessment and Mitigation Strategies	2
V	**Practical module**		**30**

		1. Field visits to ornamental fish facilities 2. Hands-on experience in disease diagnosis and treatment 3. Implementation of biosecurity measures in a practical setting 4. Case studies and group projects on health management in ornamental 5. Water Quality Assessment and Management Practices in Ornamental Fish Facilities 6. Observation and Analysis of Fish Behaviour and Health Indicators 7. Aquatic Plant Care and Maintenance Techniques 8. Practical Exercises in Fish Handling and Acclimation	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four module

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	3	2	1	2	2	3	1	2	3	2	1
CO 2	3	2	1	3	2	3	3	2	1	3	2	3	1
CO 3	2	3	2	1	3	2	2	1	3	2	1	2	3
CO 4	3	2	3	2	1	3	3	2	2	3	1	3	2
CO 5	2	1	2	3	2	1	2	3	1	2	3	2	1
CO 6	3	2	1	2	3	2	3	2	1	3	2	3	1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓	✓		✓
CO 5			✓	✓
CO 6		✓	✓	✓

Suggested reading

1. "Fish Diseases: Diagnosis and Treatment" by Edward J. Noga
2. "Handbook of Fish Diseases" by Dieter Untergasser
3. "Aquarium Fish Breeding" by Jay F. Hemdal
4. "Water Quality for Ornamental Fish" by David A. Wedemeyer
5. "Biosecurity in Aquaculture Production Systems: Exclusion of Pathogens and Other Undesirables" by Geoff Allan and Francisco J. Alday-Sanz
6. "Manual of Fish Health: Everything You Need to Know About Aquarium Fish, Their Environment and Disease Prevention" by Chris Andrews
7. "Fish Disease: Diagnosis and Treatment" by Patrick T. K. Woo and David W. Bruno

Programme	B. Sc. Aquaculture Honours					
Course Title	Business Aspects of Ornamental Fish Trade					
Type of Course	**Vocational Minor (Group1)**					
Semester	VIII					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	Business Aspects of Ornamental Fish Trade" provides a comprehensive overview of the global ornamental fish industry, covering market trends, regulatory frameworks, ethical considerations, and business management strategies essential for success in the trade.					

Course outcome

CO	Understand the structure and dynamics of the global ornamental fish industry.	Understand (U)	Conceptual Knowledge (C)	Written exams, case studies
CO1	Analyze market trends and conduct demand analysis in the ornamental fish trade.	Analyze (An)	Procedural Knowledge (P)	Quizzes, research projects
CO2	Explain the legal and regulatory frameworks governing the ornamental fish trade.	Understand (U)	Conceptual Knowledge (C)	Written exams, presentations
CO3	Evaluate ethical considerations and sustainability practices in the ornamental fish industry.	Evaluate (E)	Conceptual Knowledge (C)	Case studies, project reports
CO4	Develop effective branding and product differentiation strategies.	Create (C)	Procedural Knowledge (P)	Group projects, presentations
CO5	Apply pricing strategies and market positioning techniques in the ornamental fish trade.	Apply (Ap)	Procedural Knowledge (P)	Practical exams, seminar presentations
CO6				
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs
I	**Introduction to the Ornamental Fish Trade**		**10**
	1	Overview of the global ornamental fish industry	2
	2	Market trends and demand analysis	3
	3	Legal and regulatory frameworks in the ornamental fish trade	3
	4	Ethical considerations and sustainability practices	2
II	**Marketing Strategies and Sales Channels**		**10**
	5	Branding and product differentiation	3
	6	Pricing strategies and market positioning	3
	7	Sales channels and distribution networks	2
	8	Customer relationship management	2
III	**Business Operations and Management**		**15**
	9	Business planning and strategy development	2
	10	Operational management and logistics	2
	11	Supply chain management	1
	12	Strategic planning and goal setting for ornamental fish businesses	2
	13	Inventory management and procurement strategies	2
	14	Human resource management and employee training	2
	15	Facility layout and optimization for efficient operations	1
	16	Quality control and assurance	1
	17	Quality management systems and continuous improvement initiatives	2
IV	**Financial Management and Budgeting**		**10**
	18	Financial planning and budgeting	2
	19	Cost analysis and profit optimization	2
	20	Risk management and insurance	2
	21	Financial reporting and analysis	2
	22	Cash flow management and working capital optimization	2
V	**Practical module**		**30**
		• Field visits to ornamental fish farms and trade facilities • Hands-on experience in marketing and sales activities • Business operation simulations and case studies • Project development and presentation	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	2	2	1	3	2	1	2	2	1	2
CO 2	1	2	2	2	2	2	2	3	2	1	2	2	3
CO 3	3	2	3	1	1	1	3	1	3	2	2	2	2
CO 4	2	2	3	2	3	1	2	2	2	3	3	2	2
CO 5	2	3	1	3	2	2	2	2	2	2	3	3	2
CO 6	1	2	2	2	2	3	1	3	2	2	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓	✓		
CO 2	✓	✓		
CO 3	✓	✓		
CO 4		✓	✓	
CO 5			✓	✓
CO 6		✓	✓	

Suggested reading

1. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries
2. "Good to Great: Why Some Companies Make the Leap... and Others Don't" by Jim Collins
3. "The Art of Strategy: A Game Theorist's Guide to Success in Business and Life" by Avinash K. Dixit and Barry J. Nalebuff
4. "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen
5. "Blue Ocean Strategy: How to Create Uncontested Market Space and Make the Competition Irrelevant" by W. Chan Kim and Renée Mauborgne
6. "Start with Why: How Great Leaders Inspire Everyone to Take Action" by Simon Sinek
7. "The Tipping Point: How Little Things Can Make a Big Difference" by Malcolm Gladwell
8. "The Art of War" by Sun Tzu (for strategic thinking and business tactics)
9. "Agricultural Marketing and Price Analysis" by Andrew Barkley

Group 2 Fish Processing Technology

Programme	B. Sc. Aquaculture Honours
Course Title	Fundamentals of Fish Processing
Type of Course	**Vocational Minor (Group2)**
Semester	I
Academic Level	100-199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours

Pre-requisites	A Pass HSC/VHSC or Equivalent with biology
Course Summary	The course "Fundamentals of Fish Processing" covers essential aspects of processing techniques, including preservation methods, quality control, and safety standards, crucial for efficient and sustainable fish production

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles and significance of fish processing in aquaculture.	Understand	Conceptual Knowledge	Written exams, Assignments
CO2	Apply proper fish handling and preservation techniques to maintain product quality.	Apply	Procedural Knowledge	Practical exams, Lab reports
CO3	Demonstrate proficiency in various fish processing techniques and value-added products.	Apply	Procedural Knowledge	Practical exams, Case studies
CO4	Evaluate the quality control measures and packaging standards in fish processing.	Evaluate	Conceptual Knowledge	Presentations, Project reports
CO5	Gain practical experience in fish processing operations through hands-on activities.	Apply	Procedural Knowledge	Lab practicals, Field visits
CO6	Analyze the importance of regulatory standards and safety measures in fish processing.	Analyze	Conceptual Knowledge	Research projects, G

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Fish Processing**		**10**
	1	Overview of fish processing industry	2
	2	Importance of fish processing in aquaculture	3
	3	Basic concepts and terminology in fish processing	3
	4	Introduction to regulatory standards and safety measures	2
II	**Principles of Fish Handling and Preservation**		**10**
	5	Handling techniques to maintain fish quality	3
	6	Principles of fish preservation methods	3
	7	Role of temperature control in fish preservation	2
	8	Packaging materials and their impact on fish quality	2
III	**Fish Processing Techniques**		**15**
	9	Fish filleting and portioning methods	2
	10	Smoking, curing, and drying techniques	2
	11	Freezing and refrigeration processes	1
	12	Value-added products and processing innovations	2
	13	Innovative methods for fish dehydration and freeze-drying	2
	14	Application of high-pressure processing (HPP) in fish preservation	2
	15	Novel approaches to fish fermentation and pickling	1
	16	Utilization of nanotechnology in fish packaging and preservation	1
	17	1Emerging trends in sustainable and eco-friendly fish processing technologies	2
IV	**Quality Control and Packaging in Fish Processing**		**10**
	18	Quality assessment parameters in fish processing	2
	19	Packaging standards and techniques	2
	20	Labeling regulations and product identification	2
	21	Hazard Analysis and Critical Control Points (HACCP) in fish processing	2
	22	Quality assurance in fish processing: sensory evaluation and sensory panels	2
V	**Practical Module**		**30**
		• Hands-on experience in fish filleting and processing • Practice sessions on smoking, curing, and freezing techniques • Quality control exercises and sensory evaluation • Field visits to fish processing facilities	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	2	2	1	2	1	2	2	2	1	1
CO 2	1	2	2	2	2	2	1	2	2	2	2	2	1
CO 3	3	2	3	1	1	1	3	2	1	3	2	1	2
CO 4	2	2	3	2	3	1	2	2	2	2	2	2	2
CO 5	2	3	1	3	2	2	2	3	3	1	2	2	2
CO 6	1	2	2	2	2	3	1	2	2	2	2	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1			✓	
CO 2	✓			
CO 3			✓	
CO 4		✓		
CO 5				✓
CO 6		✓		

Suggested reading

1. "Fish Processing: Sustainability and New Opportunities" by George M. Hall
2. "Textbook of Fish Processing Technology by K.Gopakumar
3. Fish Processing Technology and Product by Arun Ninawe K. Rathnakumar
4. Textbook of Fish Processing Technology by Mukhopadhay
5. "Principles of Fish Processing" by George M. Hall
6. Textbook Of Fish Processing Technology by Mehr Deeba

Programme	B. Sc. Aquaculture Honours					
Course Title	Seafood Safety and Quality Control					
Type of Course	**Vocational Minor (Group2)**					
Semester	II					
Academic Level	100-199					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	Seafood Safety and Quality Control" provides students with comprehensive knowledge and practical skills in ensuring the safety, quality, and regulatory compliance of seafood products through a thorough examination of industry standards, regulatory frameworks, and quality assurance practices.					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the regulatory framework and standards governing seafood safety and quality.	Understand	Conceptual	Assignments, Examinations
CO2	Identify and assess various hazards in seafood and implement Hazard Analysis and Critical Control Points (HACCP).	Apply	Procedural	Case Studies, Practical Exams
CO3	Demonstrate proficiency in conducting sensory, chemical, and microbiological analysis of seafood products.	Apply	Procedural	Lab Reports, Practical Exams
CO4	Manage and mitigate contaminants in seafood processing, including toxins, heavy metals, and microbial contamination.	Apply	Procedural	Research Projects, Presentations
CO5	Implement safety protocols, risk management strategies, and crisis communication in seafood processing.	Apply	Procedural	Seminar Presentations, Group Projects
CO6	Apply quality control measures, sanitation practices, and traceability systems to ensure seafood safety and compliance.	Apply	Procedural	Practical Examinations, Field Visits

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Seafood Safety**		**10**
	1	Overview of Seafood Safety Regulations and Standards	2
	2	Hazards in Seafood: Biological, Chemical, and Physical	3
	3	Principles of Hazard Analysis and Critical Control Points (HACCP)	3
	4	Emerging Challenges in Seafood Safety	2
II	**Quality Assessment and Assurance**		**10**
	5	Sensory Evaluation of Seafood Productst	3
	6	Chemical Analysis Techniques for Quality Assessment	3
	7	Microbiological Analysis in Seafood Quality Control	2
	8	Instrumentation and Technology in Quality Assurance	2
III	**Quality Control Measures**		**15**
	9	Understanding Marine Toxins: Biotoxins and Contaminants	2
	10	Heavy Metal Contamination in Seafood: Sources and Mitigation	2
	11	Addressing Microbial Contamination in Seafood Processing	1
	12	Control Measures for Chemical Contaminants	2
	13	Understanding Marine Toxins: Biotoxins and Contaminants	2
	14	Emerging Contaminants in Seafood: Challenges and Solutions	2
	15	Heavy Metal Contamination in Seafood: Sources and Mitigation	1
	16	Advanced Techniques in Seafood Inspection and Grading	1
	17	Regulatory Compliance and International Standards in Seafood Safety	2
IV	**Sanitation in Seafood processing**		**10**
	18	Sanitation and Hygiene Practices in Seafood Processing	2
	19	Allergen Management in Seafood Handling	2
	20	Risk Communication and Crisis Management	2
	21	Ensuring Traceability and Product Recall Systems	2
	22	Regulatory Frameworks and Standards in Seafood Industry:	2
V	**Practical module**		**30**
		1. Microbiological Analysis of Seafood Samples 2. Chemical Analysis for Contaminant Detection 3. Sensory Evaluation of Seafood: 4. HACCP (Hazard Analysis and Critical Control Points) Plan Development 5. Field visits to seafood processing plants and quality control laboratories	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modules

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	2	2	2	2	2	1	2	2	2	1	2
CO 2	2	2	2	2	3	2	1	2	2	2	2	2	3
CO 3	2	2	2	2	1	1	3	2	3	1	1	1	2
CO 4	2	2	2	2	3	3	2	2	3	2	3	1	2
CO 5	2	2	1	2	2	2	2	3	1	3	2	2	2
CO 6	2	2	2	1	2	3	1	2	2	2	2	3	1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2		✓	✓	✓
CO 3			✓	
CO 4	✓			✓
CO 5			✓	✓
CO 6		✓		✓

Suggested reading

1. "Fish Quality Control by Computer Vision" by Leon Kester and John O. Sun
2. "Seafood Processing: Technology, Quality and Safety" edited by Ioannis S. Boziaris
3. "Microbiological Analysis of Food and Water: Guidelines for Quality Assurance" by A. A. Adams, M. O. Moss, and P. McClur
4. Seafood and Freshwater Toxins: Pharmacology, Physiology, and Detection" by Luis M. Botana
5. "Seafood Safety" by National Acdemics
6. Safety and Quality Issues in Fish Processing H. Allan Bremner
7. Seafood Research From Fish To Dish: Quality, Safety and Processing of Wild and Farmed Fish by J. B. Luten, and C. Jacobsen

Programme	B. Sc. Aquaculture Honours
Course Title	Value-Added Fish Products Development
Type of Course	**Vocational Minor(Group2)**
Semester	III
Academic Level	200-299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours

Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters
Course Summary	The course "Value-Added Fish Products Development" explores processing techniques, market analysis, and practical applications to enhance the value and market competitiveness of fish products through innovative processing methods and consumer-oriented strategies.

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the concept of value addition in the fish processing industry	Understand (U)	Conceptual Knowledge (C)	Written exams, quizzes, case studies
CO2	Apply techniques for developing new value-added fish products	Apply (Ap)	Procedural Knowledge (P)	Practical exams, lab reports, project reports
CO3	Analyze the market trends and consumer preferences in the fish product market	Analyze (An)	Conceptual Knowledge (C)	Case studies, research projects, presentations
CO4	Evaluate strategies for branding, packaging, and product differentiation	Evaluate (E)	Conceptual Knowledge (C)	Group projects, seminar presentations, case studies
CO5	Demonstrate proficiency in processing and developing various value-added fish products	Apply (Ap)	Procedural Knowledge (P)	Practical exams, lab practicals, field visits
CO6	Integrate knowledge of fish processing techniques with market demands	Create (C)	Conceptual Knowledge (C)	Project reports, group projects, presentation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Value-Added Fish Products**		**10**
	1	Overview of value addition in the fish processing industry	2
	2	Importance of value-added products for market competitiveness	3
	3	New Product development	3
	4	Understanding packaging materials and methods for value-added fish products	2
II	**Processing Techniques for Value Addition**		**10**
	5	Smoking, curing, and drying methods	3
	6	Marination, pickling, and seasoning techniques	3
	7	Fermentation and enzyme-based processes	2
	8	Incorporating novel ingredients and flavors	2
III	**Value-Added Fish Products and By-Products**		**15**
	9	Fish fillets: Smoked, marinated, and flavored variants	2
	10	Fish cakes and nuggets: Breaded, stuffed, and seasoned varieties	2
	11	Surimi and imitation seafood products	1
	12	Fish oil and omega-3 supplements	2
	13	Fish meal and fish protein concentrates	2
	14	Fish Roe Products	2
	15	Fish Skin and Collagen Products	1
	16	Fish By-Product Utilization	1
	17	Innovative Packaging and Presentation	2
IV	**Market Analysis and Consumer Trends**		**10**
	18	Analysis of consumer preferences and trends in the fish product market	2
	19	Market segmentation and target audience identification	2
	20	Strategies for product positioning and market penetration	2
	21	Branding, packaging, and product differentiation strategies	2
	22	Understanding the role of wholesalers, retailers, and e-commerce platforms	2
V	**Practical module**		**30**
	1	1. Development of Fish-Based Snack Products 2. Smokehouse Experimentation 3. Marination and Curing Studies 4. Extrusion Processing of Fish 5. Fermentation of Fish 6. Formulation and production of value-added fish products 7. Quality assessment and sensory evaluation of finished products 8. Field visits to fish processing facilities and marketplaces	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modul

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	1	2	2	1	3	2	3	2	2	1	2
CO 2	1	2	2	2	2	2	2	3	2	3	2	2	3
CO 3	3	2	3	1	1	1	3	3	2	1	2	2	1
CO 4	2	2	3	2	3	1	2	3	3	2	3	2	1
CO 5	2	3	1	3	2	2	2	2	3	1	2	3	2
CO 6	1	2	2	2	2	3	1	2	2	2	3	2	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5	✓		✓	✓
CO 6		✓	✓	✓

Suggested reading

1. Accelerating New Food Product Design and Development by Jacqueline H. Beckley
2. Functional Ingredients from Algae for Foods and Nutraceuticals" edited by Herminia Dominguez
3. "Innovative Food Processing Technologies: A Comprehensive Review" by K. J. Buckle
4. "Value-Added Products from Beekeeping" by R. Krell
5. Value Added Products From Food Waste by Elsa Cherian, Gurunathan Baskar
6. Fish processing Technology by Gopakumar

Programme	B. Sc. Aquaculture Honours					
Course Title	Advanced Packaging and Preservation Techniques					
Type of Course	**Vocational Minor(Group2)**					
Semester	VIII					
Academic Level	300-399					
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours	Exam Duration
	4	3	-	2	75	2 hours
Pre-requisites	A Pass in HSE/VHSE or Equivalent with biology Should have completed previous semesters					
Course Summary	The course "Advanced Packaging and Preservation Techniques" provides an in-depth exploration of modern packaging and preservation technologies, focusing on their applications in enhancing the shelf life, safety, and sustainability of aquaculture products.					

Course outcome

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understanding the fundamentals of packaging technologies and their role in food preservation.	U	Conceptual Knowledge	Written exams, quizzes
CO2	Ability to identify and evaluate different packaging materials and methods based on their suitability and effectiveness.	An	Procedural Knowledge	Lab reports, case studies
CO3	Applying design principles to develop packaging solutions that meet specific requirements and address sustainability concerns.	Ap	Procedural Knowledge	Project reports, presentations
CO4	Analyzing advanced packaging technologies and their applications in food preservation and quality enhancement.	An	Conceptual Knowledge	Research projects, group projects
CO5	Evaluating regulatory standards, safety considerations, and consumer preferences in packaging and food preservation.	E	Factual Knowledge	Seminar presentations, case studies
CO6	Demonstrating practical skills in assessing the effectiveness and performance of various packaging and preservation techniques.	Ap	Procedural Knowledge	Lab practicals, field trips, practical exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive				

Knowledge (M)

Module	Unit	Content	Hrs
I	**Introduction to Packaging Technologies**		**10**
	1	Overview of Packaging	2
	2	Materials and Methods for Packaging	3
	3	Design Considerations	3
	4	Sustainability in Packaging	2
II	**Preservation Techniques**		**10**
	5	Principles of Food Preservation	3
	6	Chemical Preservation Methods	3
	7	Physical Preservation Methods	2
	8	Biological and Natural Methods	2
III	**Advanced Technologies in Packaging and Preservation**		**15**
	9	Active Packaging Solutions	2
	10	Smart Packaging Technologies	2
	11	Vacuum Packaging.	1
	12	Intelligent Packaging Systems	2
	13	Edible Packaging Innovations	2
	14	Nanotechnology in Packaging	2
	15	Biodegradable and Bio-based Packaging	1
	16	Integration of Packaging and Preservation Techniques	1
	17	Regulatory and Safety Considerations	2
IV	**Quality Control and Assurance**		**10**
	18	Standards and Regulations	2
	19	Quality Assurance Techniques	2
	20	Risk Assessment	2
	21	Consumer Preferences and Market Trends	2
	22	Case Studies	2
V	**Practical Module**		**30**
	1	1. Effectiveness of Modified Atmosphere Packaging 2. Comparative Study of Active vs. Passive Packaging 3. Testing Smart Packaging Sensors 4. Vacuum Packaging Efficiency 5. Edible Packaging Application 6. Nanotechnology in Packaging 7. Biodegradable Packaging Performance Test 8. Field trips to processing plants and packaging facilities to understand real-world applications.	

Note: The syllabus has five modules. There should be total 22 units in the first four modules composed of the theory topics. The number of units in the last module can vary. There are 45 instructional hours for the first four modules and 30 hrs for the final one. Module V is designed to equip students with practical skills. The 20 marks for the evaluation of practical will be based on Module V. The end-semester examination for the theory part will be based on the 22 units in the first four modu

CO-PO and CO PSO mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	2	2	1	2	3	2	1	2	2	1
CO 2	1	2	2	2	2	2	3	2	3	1	2	2	1
CO 3	3	2	3	1	1	1	2	3	2	2	3	2	1
CO 4	2	2	3	2	3	1	2	2	3	1	2	3	1
CO 5	2	3	1	3	2	2	2	3	2	2	2	2	1
CO 6	1	2	2	2	2	3	1	2	2	2	2	3	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
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Assessment Rubrics:

Assignment

Seminar presentation

Internal exam

End semester examination

Mapping of COs to Assessment Rubrics:

	Assignment	Seminar presentation	Internal examination	End Semester Examinations
CO 1	✓		✓	
CO 2	✓	✓	✓	
CO 3	✓			✓
CO 4		✓	✓	✓
CO 5			✓	✓
CO 6		✓	✓	✓

Suggested reading

1. "Food Packaging: Principles and Practice" by Gordon L. Robertson
2. "Innovations in Food Packaging" by Jung H. Han
3. Principles of Food Chemistry" by John M. deMan
4. Active Packaging for Food Applications" by Aaron L. Brody, E. P. Strupinsky, and Lauri R. Kline
5. "Food Packaging Technology" edited by Richard Coles and Derek McDowell
6. "Preservation and Shelf Life Extension: UV Applications for Fluid Foods" by Tatiana Koutchma

List of Online Courses

SL no	Title of the course	Academic level	Duration	Equivalent credit	Equivalent Course in CUFYUGP with Course Code	Repository	Weblink
1	Fish and Fisheries	300-399	12 weeks	4		Swayam	https://onlinecourses.swayam2.ac.in/cec21_bt01/preview
2	Advanced Aquaculture Technology	300-399	12 weeks	4		Swayam	https://onlinecourses.nptel.ac.in/noc23_ag11/preview
3	Introduction to Seaweeds	200 - 299	7 weeks	3		Coursera	https://www.coursera.org/learn/introduction-to-seaweeds/home/info
4	Large marine Ecosystems	200-299	6week	3		Coursera	https://www.coursera.org/learn/large-marine-ecosystems/home/info

<u>Model Question papers</u>

Model Question Paper

First Semester

Major CORE

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC1CJ101Fundamentals of Aquaculture

Credits 4

Maximum time 2 hours | Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

1. Describe the role of aquaculture in global food security.
2. Outline the basic principles of fish biology that are crucial for aquaculture.
3. Discuss the historical development of aquaculture and its impact on modern practices.
4. Compare and contrast extensive, intensive, and integrated aquaculture systems.
5. Explain the importance of water quality management in aquaculture systems.
6. List three primary components of fish nutrition and their significance in aquaculture.
7. What are the common diseases affecting aquaculture and the principles of health management?
8. Summarize the principles of fish breeding in aquaculture.
9. How does hatchery management contribute to the success of aquaculture operations?
10. Define sustainable aquaculture and explain its importance

Section B

Answer all question each question carries 6 marks

Ceiling 36

11. Discuss the environmental impacts of aquaculture practices and propose mitigation strategies.
12. Explain the techniques involved in the selective breeding of fish for desirable traits.
13. Describe the process and criteria for brood stock selection in aquaculture.
14. How do market trends and trade influence aquaculture practices globally?
15. Evaluate the role of biotechnology in enhancing fish breeding and its ethical considerations.
16. Outline the steps involved in business planning and economics of aquaculture operations.
17. Discuss the significance of aquaculture certification and ecolabeling in promoting sustainable practices.

18. Describe the rearing techniques for different aquatic species and their specific requirements.

Section C

Answer any one. Each question carries 10 marks

1X10= 10

19. Write a comprehensive essay on the challenges faced by aquaculture in terms of sustainability and how these challenges can be transformed into opportunities for the industry.

20. Discuss the recent innovations in aquaculture practices, focusing on how they contribute to the efficiency and sustainability of aquaculture operations.

Second Semester

B.Sc. Aquaculture Honours Degree Examinations

CUFYUGP examination

AQC2CJ101 Foundations of Aquatic biology

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks Ceiling 24

1. Define salinity and its biological significance in aquatic environments.
2. Describe the role of phytoplankton in marine ecosystems.
3. Explain the concept of population dynamics in aquatic environments.
4. What are the main characteristics of freshwater ecosystems?
5. List three types of adaptations that help fish survive in aquatic environments.
6. What are the ecological roles of invertebrates in aquatic systems?
7. Discuss the importance of light in influencing life in aquatic habitats.
8. What is eutrophication and how does it impact aquatic systems?
9. Outline the steps involved in hypothesis development for aquatic research.
10. Describe the role of dissolved oxygen in water bodies.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Describe the methods used for sampling biota in aquatic environments and discuss their effectiveness.
12. Explain the nitrogen and phosphorus cycles in aquatic systems and their importance for aquatic life.
13. Discuss the different types of microbial interactions in aquatic microbial ecology.
14. Illustrate the process of ecological succession in aquatic habitats with examples.
15. Explain the principles of scientific method in aquatic research, including experimental design.
16. Describe the adaptations of aquatic plants and macrophysics to their environment.
17. Discuss the impact of climate change on aquatic environments and potential adaptations of aquatic species.

18. Analyse the effects of human impacts like pollution and habitat destruction on aquatic ecosystems.

Section C

Answer any one. Each question carries 10 marks. Total: 10 marks

19. Discuss the methods for water quality analysis in aquatic environments and their significance in ecosystem management.

20. Explain the importance of scientific communication in aquatic biology, focusing on the structure of scientific papers and presentations.

Third Semester

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC3CJ201 Aquaculture Genetics and Biotechnology

Maximum time 2 hours

Credit-4 Maximum marks70

Section A Ceiling -24

Answer all questions each question carries 3mark

1. List three fundamental differences between prokaryotic and eukaryotic cells.
2. Describe the function of the nucleus in a eukaryotic cell.
3. Explain the roles of mitochondria and chloroplasts in a cell.
4. Differentiate between mitosis and meiosis in terms of their process and outcome.
5. State Mendel's law of segregation and its significance in genetics.
6. Explain what is meant by incomplete dominance and provide an example.
7. Define monosomy and trisomy and mention one consequence of each.
8. Describe what mutations are and how mutagens can influence them.
9. What is selective breeding in aquaculture, and why is it important?
10. Explain the role of genetic markers in aquaculture.

Section B Ceiling-36

Answer all questions . Each question carries 6marks

11. Discuss the importance of chloroplasts in photosynthesis and compare it to the function of mitochondria in cellular respiration.
12. Illustrate how Mendel's laws apply to an example of a dihybrid cross.
13. Describe the process and implications of chromosomal translocations in genetics.
14. Explain the process and benefits of creating transgenic fish for aquaculture.
15. Discuss the methods and advantages of chromosome manipulation in aquaculture, specifically focusing on polyploidy.
16. Outline the techniques for producing monosex populations of fish and their benefits in aquaculture.
17. Describe the process and applications of synthetic hormone production for induced breeding in aquaculture.

18. Explain the principle and applications of cryopreservation in aquaculture.

Section C (10 Marks Each) 10X1=10

19. Evaluate the role of molecular diagnostics and immunological techniques in managing aquatic animal health, discussing the benefits and limitations of current methods.

20. Assess the impact of biotechnological advancements on environmental sustainability in aquaculture, focusing on waste management and water quality improvement. Discuss the challenges faced and potential future directions.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC3CJ202Biology of fishes

Credit 4

Maximum time 2 hours

Maximum marks70

Section A

Answer all questions. Each question carries 3 marks Ceiling 24

1. Describe the role of fins in fish locomotion.
2. Explain the phenomenon of bioluminescence in fishes and its ecological benefits.
3. Outline the principles of zoological classification as applied to aquatic species.
4. What is binomial nomenclature? Provide examples for two important aquatic species.
5. Discuss the feeding adaptations observed in predatory fish.
6. What is gut content analysis, and why is it important in studying fish diets?
7. Describe a method used for determining the age of fish.
8. List the basic nutritional requirements for a typical marine fish.
9. Explain the significance of sexual dimorphism in fish reproduction.
10. What are the main types of migration observed in fishes, and why do they migrate?

Section B Ceiling 36

Answer all questions. Each question carries 6marks

11. Compare and contrast the reproductive strategies of bony fishes and shellfishes.
12. Discuss the adaptations that enable deep-sea fishes to live in extreme environments.
13. Explain how the cardiovascular system in fish is adapted to their aquatic environment.
14. Describe the process and importance of osmoregulation in marine fishes.
15. Analyze the role of the immune system in fish, highlighting its importance in aquaculture.
16. Outline the endocrine control of reproduction in aquatic species.
17. Discuss the dietary variations across different aquatic species and their impact on aquaculture practices.
18. Explain the mechanisms of excretion in fishes and their role in maintaining homeostasis.

Section C

Answer any one question Each question carries 10 mark 10X1 =10

19. Discuss the role of fish endocrinology in aquaculture, focusing on how hormonal control influences growth and reproduction.
20. Discuss the role of fish endocrinology in aquaculture, focusing on how hormonal control influences growth and reproduction.

Fourth Semester

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC4CJ203 Ornamental Fish Culture and Management

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

Answer all questions

1. Briefly describe the ornamental fish industry and its global significance.
2. Why are ornamental fish considered important in aquaculture?
3. List three major species of ornamental fish and their basic ecological needs.
4. What are the essential components of an aquarium setup?
5. Describe the process of setting up an under-gravel filter in an aquarium.
6. How is water quality maintained in an aquarium to control snail and algal growth?
7. Explain the proper methods for handling, care, and transportation of ornamental fish.
8. What is the principle behind the design of a Recirculating Aquaculture System (RAS)?
9. Discuss the breeding habits and parental care of any one species of ornamental fish.
10. What are the nutritional requirements of ornamental fish?

Section B

Answer all questions Each question caries 6marks Ceiling 36

11. Compare and contrast the ecological needs of live bearers and cichlids.
12. Describe the steps involved in maturation and spawning of koi.
13. Outline the commercial production process of goldfish, including key stages from breeding to sale.
14. Discuss the significance of indigenous ornamental fishes in Kerala, focusing on major species and their distribution.
15. Explain the process of seed production for "Miss Kerala."
16. Describe the taxonomy, morphology, and multiplication methods of important freshwater plants in aquaculture.

17. How is mass production of aquarium plants achieved, and what are its challenges?
18. Explain the types of feeds and feeding strategies for ornamental fish to ensure optimal growth and coloration.

Section C 1X10= 10

Answer any one. Each question carries 10 marks

19. Discuss market trends in the ornamental fish industry and their impact on production and export/import practices.
20. Evaluate the environmental impacts of ornamental fish culture and the role of conservation programs in sustainability.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC4CJ204Aquaculture Nutrition and Feed Technology

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

Answer all questions

1. Define aquaculture nutrition and its importance.
2. Describe the basic digestive physiology of finfish.
3. List three essential nutrients and their functions in aquatic species.
4. Identify two common nutritional disorders in aquaculture and their causes.
5. What are the primary types of feed ingredients used in aquaculture?
6. Explain the significance of diet formulation for ornamental fishes.
7. Mention one novel ingredient in aquaculture feeds and its benefit.
8. Define what is meant by "functional feed ingredients."
9. What are the key principles of feed formulation?
10. Describe one sustainable feed production practice in aquaculture

Section B

Answer all questions. Each question caries 6marks Ceiling 36

11. Compare and contrast the digestive physiology of shellfishes with finfishes.
12. Discuss the process and challenges of diet formulation for different aquatic species.
13. Explain the role of feed additives in aquaculture nutrition.
14. Outline the steps involved in feed production and mention one technique for ensuring feed quality.
15. Describe the environmental impacts of feed production in aquaculture.
16. How does nutritional genomics influence aquaculture feed development?
17. Discuss the concept and benefits of nutraceuticals in aquaculture feeds.

18. Analyze the emerging trends in aquaculture feed technology and their potential impacts.

Section C 1X10= 10

Answer any one. Each question carries 10 marks

19. Discuss how feeding strategies and feed efficiency affect water quality in aquaculture.
20. Explain precision feeding in aquaculture and its benefits for sustainability.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC4CJ 205Freshwater & Brackish water aquaculture

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

Answer all questions

1. Define freshwater aquaculture and mention two types of freshwater aquaculture systems.
2. List three key water quality parameters in freshwater aquaculture and their ideal ranges.
3. Describe the importance of pond preparation and fertilization.
4. Name two major freshwater fishes cultured in India and mention one culture technique for each.
5. Explain the significance of freshwater pearl culture in India.
6. What is *Macrobrachium rosenbergii* and why is it important in aquaculture?
7. Discuss the concept of sewage-fed fish culture.
8. Define brackish water aquaculture and compare it with freshwater aquaculture.
9. Mention two species commonly cultured in brackish water aquaculture.
10. Explain the basic principle of Biofloc technology in brackish water aquaculture.

Section B

Answer all questions. Each question caries 6marks Ceiling 36

11. Compare and contrast the pond preparation techniques between freshwater and brackish water aquaculture.

12. Describe the production techniques and management practices for culturing carps.

13. Discuss the current status and challenges of freshwater pearl culture in India.

14. Outline the culture techniques for *Penaeus monodon*.

15. Explain the significance and management practices of sewage-fed fish culture in India.

16. Discuss the techniques for culturing milkfish in brackish water.

17. Describe the principles and practices of Integrated Multi-Trophic Aquaculture (IMTA) in brackish waters.

18. Evaluate the environmental impacts of brackish water aquaculture and strategies for mitigation.

Section C

Answer any one question. Each question carries 10marks 1X10= 10

19. Evaluate sustainable practices in brackish water aquaculture for improving productivity and sustainability.

20. Discuss the contribution of aquaculture to farm tourism and ecotourism, focusing on benefits and challenges

Fifth Semester

Major CORE

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5CJ301Mariculture

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

Answer all questions

1. Define mariculture and explain its importance in modern fisheries.
2. Distinguish between mariculture, aquaculture, and traditional fishing.
3. List three basic biological principles critical to marine farming.
4. Discuss the current status of mariculture globally.
5. Describe three types of mariculture systems and mention one advantage of each.
6. Explain the role of technology in enhancing mariculture efficiency.
7. What are some sustainable practices that can be adopted in mariculture?
8. Identify two criteria for selecting species for mariculture and why they are important.
9. Describe the ecological needs of one specific finfish species used in mariculture.
10. Outline the design considerations for open ocean cages in mariculture.

Section B

Answer all question each question carries 6 marks Ceiling 36

11. Discuss the various innovations in mariculture systems and their potential impacts on productivity.
12. Compare and contrast land-based RAS with open ocean cages in terms of environmental impact and sustainability.
13. Describe the Integrated Multi-Trophic Aquaculture system and its benefits to finfish culture.
14. Explain the process of broodstock management and its significance in genetic improvement of mariculture species.

15. Detail the techniques used in larval rearing and nursery management in finfish culture.
16. Outline the key components of health management in finfish culture.
17. Discuss the principles and applications of vaccination in mariculture. What are the challenges involved?

Section C

Answer any one question each question carries 10marks 10X1=10

19. Evaluate the environmental impacts of mariculture, including eutrophication, habitat destruction, and species escapes, providing examples of mitigation strategies.
20. Analyze a case study of successful mariculture, discussing the biological, economic, and environmental factors involved.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5CJ302 Fishing Techniques and Practices

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks Ceiling 24

1. Briefly explain the principle behind the evolution of fishing methods and gear.
2. What is the significance of understanding the marine environment in fisheries?
3. Define responsible fisheries and mention one key aspect.
4. What does CCRF stand for, and why is safety at sea important?
5. Name two types of fishing crafts used in India and describe one difference between them.
6. Describe the main function of trawlers in marine fishing.
7. What is the purpose of purse seiners in fishing?
8. List one characteristic of gill netters.
9. Identify one modern fishing gear and its use.
10. What are active gears, and give one example.

Section B Ceiling 36

Answer all questions each question carries 6 marks

11. Compare and contrast motorized and mechanized fishing crafts.
12. Explain the operation of trawls and how they differ from ring seines.
13. Describe the design and function of long lines and how they are used in fisheries.
14. Discuss the impact of destructive fishing methods on marine ecosystems.
15. Provide introductory information on sonar technology and its role in fisheries.
16. Explain the Code of Conduct for Responsible Fishing.

17. What are Turtle Exclusion Devices (TED) and how do they work?
18. Describe the materials used in modern fishing craft construction

Section C 1X10= 10

Answer any one question. Each question carries 10 marks

19. Discuss how technology in fishing gear and devices supports sustainable fishing.
20. Analyze the impact of modern fishing crafts and materials on fisheries' sustainability and productivity.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5CJ303Fish Processing Technology

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks Ceiling 24

1. Explain the basic principles of fish preservation and their importance.
2. Discuss the importance of hygiene and sanitation in fish handling.
3. How do the quality of water and ice affect fish handling and processing?
4. Describe the process and benefits of chilling and icing fish.
5. List the principles involved in smoking, drying, and salting fish.
6. Identify two types of drying methods for fish and factors affecting them.
7. What are the modern methods of fish preservation by irradiation?
8. Explain the concept of accelerated freeze drying in fish processing.
9. Describe the fundamental principles involved in the freezing of fish.
10. What are the various methods used for freezing fish and fishery products?

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Compare and contrast the effects of different freezing methods on the quality of shrimps and fishes.
12. Explain the preparation process of fish fillets and its importance in the fish processing industry.
13. Discuss the changes that occur during the cold storage of fish and how they affect product quality.
14. Outline the canning process of fish and the principles involved.

15. Detail the stages involved in the canning of tuna and the significance of each stage.
16. What is retortable pouch processing, and how does it benefit the fish processing industry?
17. Discuss the significance of cut open tests, commercial sterility, and F value in fish canning.
18. Describe the process of value addition in seafood and its advantages to producers and consumers.

Section C

Answer any one question. Each question carries 10 marks (10X1=10)

19. Analyze the economic significance of various fishery by-products such as fish meal, fish protein concentrate, and others listed in the syllabus. Include the impact on sustainability and resource management.
20. Evaluate the practical module's activities including the determination of moisture content, processing of shrimp, and preparation of value-added products. Discuss how these practices contribute to the industry's standards and quality.

Fifth Semester

Major Elective

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5EJ301 Aquaponics and Integrated Farming Systems

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions, each question carries 3 marks Ceiling 24

1. Define aquaponics and describe the basic components of an aquaponics system.
2. Explain the symbiotic relationship between plants and aquatic animals in an aquaponics system.
3. Describe the underlying principles of aquaponics and the process involved in establishing an aquaponic cycle.
4. Compare and contrast three types of aquaponics systems: media-filled beds, NFT (Nutrient Film Technique), and DWC (Deep Water Culture).
5. What are the key water quality parameters in aquaponics, and how are they maintained?
6. Discuss the criteria for selecting fish for aquaponics systems and outline their care and management.
7. Identify compatible plant species for aquaponics and explain their cultivation requirements.
8. Describe nutrient dynamics in aquaponics, including cycles, supplementation, and management.
9. What are integrated farming practices, and how do they relate to aquaponics?
10. Describe the fish-duck culture system and its benefits to integrated farming.

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Outline the fish-rice culture system and discuss its advantages and disadvantages.
12. Explain how fish-vegetable culture systems work and their benefits to sustainable agriculture.
13. Discuss the integration of livestock such as pigs and cattle with fish culture, including the synergies created.
14. Evaluate the fish-seaweed and fish-mushroom culture systems in terms of environmental impact and productivity.

15. Describe the components of an Integrated Crop-Livestock-Fish System and its significance for sustainable farming.
16. Discuss sustainability practices in integrated farming systems.
17. Analyze the economic aspects of integrated farming, including cost factors and profit potential.
18. Identify emerging technologies in integrated farming systems and their potential impact on agricultural practices.

Section C

Answer any one question. Each question carries 10 marks (10X1=10)

19. Evaluate the benefits and challenges of integrated farming systems, providing examples of successful global and local case studies.
20. Design a small-scale integrated farm as a practical project. Outline the plan, the species involved, and the expected interactions and benefits.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5EJ 302Climate change and Aquatic resources

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions, each question carries 3 marks Ceiling 24

1. What are the primary causes of climate change and its global effects?
2. Explain the role of greenhouse gases in climate change.
3. Describe how climate change impacts global weather patterns, particularly temperature and precipitation changes.
4. Discuss the importance of climate change communication and raising public awareness.
5. What are the effects of climate change on marine ecosystems, specifically regarding ocean acidification and coral reefs?
6. How does climate change affect freshwater ecosystems, including river flows and lake temperatures?
7. Explain the consequences of biodiversity loss and species migration in aquatic environments due to climate change.
8. Describe the phenomenon of ocean deoxygenation and its effects on aquatic life.
9. What are the risks of climate change to aquaculture?
10. Outline adaptation strategies for aquaculture to combat climate change impacts.

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Discuss the impact of climate-induced changes on aquatic pathogens and disease dynamics in aquaculture.
12. Describe strategies to reduce the carbon footprint of aquaculture operations.
13. Explain the principles and benefits of Integrated Multi-Trophic Aquaculture (IMTA) and Recirculating Aquaculture Systems (RAS).
14. What are ecosystem-based aquaculture management practices and their significance in conservation and restoration of aquatic habitats?
15. Discuss the role of blue carbon ecosystems in carbon sequestration and their relevance to aquaculture.

16. Describe techniques for improving water use efficiency in aquaculture and the importance of managing the water footprint.
17. Outline the key components of policy and governance that support climate-resilient aquaculture, including international agreements and national strategies.
18. Analyze the impact of monsoon variability on aquaculture in India and the role of mangrove ecosystems in mitigating these effects.

Section C

Answer any one question. Each question carries 10 marks (10X1=10)

19. Evaluate global case studies on the adaptation strategies and mitigation practices used in aquaculture to address climate change, discussing their outcomes and lessons learned.
20. Assess the potential of technological innovations and traditional knowledge in enhancing climate resilience in Indian aquaculture, including policy frameworks that support these advancements.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5EJ 303 Blue economy and Aquaculture

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. What are the key principles of the blue economy?
2. Identify three major stakeholders in the blue economy.
3. Discuss the role of natural capital in the blue economy.
4. What is meant by 'valuing ecosystem services'?
5. List two SDGs that directly relate to the blue economy.
6. Explain the importance of marine biodiversity for the blue economy.
7. What are the primary goals of sustainable fisheries?
8. Describe two sustainable aquaculture practices.
9. How does marine bioprospecting contribute to the blue economy?
10. Differentiate between the green and blue economies.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe the linkage between Sustainable Development Goals (SDGs) and the Blue Economy. Provide examples.
12. What are the prospects and opportunities presented by the blue economy for marine conservation?
13. Discuss the environmental sustainability challenges within the blue economy.
14. Explain how marine pollution affects the blue economy and mention potential mitigation strategies.
15. Detail the significance of green shipping and port management in reducing marine environmental impacts.

16. Outline the contributions of marine renewable energy to the blue economy.
17. Describe sustainable practices in marine tourism that contribute to ocean health.
18. Discuss the impact of international maritime law (UNCLOS) on marine waste management strategies.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Evaluate the comprehensive impact of aquaculture on the blue economy, considering both its economic benefits and environmental challenges.
20. Analyze the role of international agreements in shaping marine conservation strategies, focusing on their effectiveness and areas for improvement.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC 5EJ304Fish Biochemistry

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions, each question carries 3 marks Ceiling 24

1. List the main biochemical constituents found in fish, crustaceans, and mollusks.
2. Describe the classification of fish proteins and name the three types discussed in the syllabus.
3. What are the post-mortem biochemical changes that occur in fish muscles, including rigor mortis?
4. Explain the significance of non-protein nitrogenous compounds and the K value in fish.
5. Describe the functional properties of seafood proteins such as solubility and emulsification.
6. What does the process of 'Salting out' entail in the context of seafood proteins?
7. Explain the terms 'denaturation' and 'coagulation' of proteins.
8. How do proteins change during the processing of seafood?
9. Discuss the composition and nutritive value of seafood lipids.
10. What roles do triglycerides and phospholipids play in the nutritional profile of seafood?

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Explain the classification of fatty acids and provide examples relevant to seafood.
12. Describe the significance of MUFA, PUFA, and Omega-3 fatty acids in human nutrition.
13. What is auto-oxidation of fatty acids, and how does it contribute to rancidity in seafood?
14. Discuss the role of lipases and phospholipases in the degradation of seafood lipids.
15. Explain the use of pro- and anti-oxidants in managing the quality of seafood products.
16. Describe the oxidation indices commonly used in the seafood industry, such as Peroxide value, TBA value, and FFA value.
17. Discuss the structure and function of enzymes as they relate to seafood.
18. Explain the kinetics of enzyme activity, including concepts like KM value and turnover number.

Section C

Answer any one question. Each question carries 10 marks

19. Evaluate the importance of polysaccharides such as chitin, chitosan, and glucosamine derived from seafood, discussing their preparation, properties, and commercial applications.

20. Analyze the mechanisms of enzyme activity in seafood, including classification, and discuss the roles of specialized enzymes like ribozymes and abzymes in biotechnological applications.

VI the Semester

Major CORE

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6CJ304Aquaculture Engineering and Technology

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions, each question carries 3 marks Ceiling 24

1. What are the principles of aquaculture engineering that need to be considered when designing an aquaculture system?
2. List three criteria for selecting an aquaculture site that are relevant for freshwater systems.
3. Describe the chain survey method used in aquaculture site surveying.
4. Explain the importance of soil sampling methods and how they help prevent erosion in aquaculture settings.
5. Identify two types of equipment commonly used in freshwater aquafarms and their purposes.
6. What role does a sluice gate play in aquaculture farm design?
7. Describe how a paddle wheel aerator functions in a culture pond.
8. Compare centrifugal pumps to submersible pumps in terms of their application in aquaculture.
9. What are the primary considerations when designing a Recirculating Aquaculture System (RAS)?
10. Outline the basic components required in a shrimp hatchery setup.

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Discuss the design and management aspects of cage culture systems in aquaculture.
12. Explain the construction and management considerations for pond culture systems.
13. Describe the raceway system in aquaculture, focusing on design, flow control, and management.
14. What technologies are used in broodstock management, and why are they important?

15. Detail the water treatment technologies used in aquaculture, including filtration and disinfection methods.

16. Discuss the design considerations and operational strategies for an effective hatchery system.

17. How do automated feeding systems improve feed management in aquaculture?

18. Explain the role of sensors and instrumentation in monitoring water quality and fish behavior.

Section C

Answer any one question. Each question carries 10 marks

19. Evaluate the impact of automation technologies on the efficiency and productivity of modern aquaculture systems, citing specific examples.

20. Design a comprehensive biosecurity plan for an aquaculture facility, detailing key components and strategies to prevent disease outbreaks and ensure the health of aquatic organisms.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6CJ305Biostatistics and Bioinformatics

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions, each question carries 3 marks Ceiling 24

1. List three methods of data collection in aquaculture research.
2. Describe the importance of diagrammatic representation of data in statistical analysis.
3. Define and differentiate between the arithmetic mean, median, and mode.
4. How do the geometric mean and harmonic mean differ from the arithmetic mean?
5. What is the range in a data set and why is it important?
6. Explain the concept of mean deviation and its application in aquaculture data analysis.
7. What does standard deviation tell you about a data set?
8. Define skewness and kurtosis in the context of data distribution.
9. How does correlation differ from regression in statistical analysis?
10. What is the significance of bioinformatics in aquaculture?

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Describe the basic concepts of molecular biology and genetics that are fundamental to bioinformatics.
12. Discuss the role of primary databases like GenBank in aquaculture research.
13. Explain the principles of sequence alignment and its importance in genetic studies.
14. What tools are commonly used for sequence alignment and what are their specific functions?
15. Outline the steps involved in building a phylogenetic tree and its applications in aquaculture.
16. Describe the applications of molecular markers in studying genetic diversity within aquaculture species.
17. Discuss the strategies for applying molecular markers in selective breeding programs for aquaculture.

18. Explain how bioinformatics tools can be utilized to analyze disease-associated genes in aquaculture species.

Section C

Answer any one question. Each question carries 10 marks

19. Analyze the impact of bioinformatics on the improvement of quantitative traits such as growth, yield, and disease resistance in aquaculture species. Detail specific bioinformatics tools and techniques used in these analyses.

20. Explore novel bioinformatics approaches and technologies that are shaping the future of sustainable aquaculture. Discuss their potential applications and benefits in detail.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6CJ306 Fishery Microbiology and Quality Control

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions, each question carries 3 marks Ceiling 24

1. Discuss the contributions of Louis Pasteur to the field of microbiology.
2. List the general characteristics common to bacteria and fungi.
3. Explain how microscopy techniques are applied in microbial structure biology.
4. Describe the ultrastructure and function of prokaryotic cells.
5. What are the main microbial flora found in aquatic environments?
6. Discuss the impact of environmental factors on the growth of prokaryotic organisms.
7. What role do microbial dynamics play in aquaculture ponds?
8. How do biogeochemical cycles depend on autotrophic and heterotrophic microorganisms?
9. Identify the main spoilage microflora associated with fish and shellfish.
10. What are intrinsic and extrinsic factors that affect seafood spoilage?

Section B

Answer all questions each question carries 6 marks Ceiling 36

11. Describe the health risks associated with filter-feeding bivalve shellfish and the process of their depuration.
12. Explain the different types of spoilage that can occur in fishery products.
13. Outline the basic concepts of quality control in seafood safety.
14. Discuss the major risk factors associated with seafood consumption.
15. What are HACCP, SSOP, and GMP, and how do they relate to seafood safety?
16. Describe the methods used to evaluate fish freshness and quality.
17. Explain the significance of isolation and enumeration of bacteria from aquatic environments like water and sediment.
18. Discuss the isolation and cultural characteristics of Vibrio sp. and its importance in aquaculture.

Section C

Answer any one question. Each question carries 10 marks 10X1=10

19. Evaluate the methods for isolating and characterizing Salmonella sp., E. coli, and Staphylococcus aureus from aquatic environments, including their cultural characteristics and relevance to food safety.

20. Analyze the practical applications and techniques used in the practical module, such as sterilization, media preparation, and bacterial isolation from fish and water, and their importance in maintaining seafood quality and safety.

VIth Semester

Major-Electives

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6EJ305Aquatic Animal Health and Disease Management

Credits 4

Maximum time 2 hours Maximum marks70

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. What are the main contributions of Louis Pasteur to the field of microbiology relevant to aquaculture?
2. Identify three general characteristics common to bacteria and fungi.
3. How are microscopy techniques applied in microbial structure biology to study aquatic pathogens?
4. Describe the ultrastructure of prokaryotic cells and its implications for pathogenicity in aquatic environments.
5. List the main microbial flora found in freshwater aquatic environments and their role in the ecosystem.
6. Discuss the impact of environmental factors on the growth of aquatic microbial populations.
7. What role do microbial dynamics play in the health of aquaculture ponds?
8. Explain how autotrophic and heterotrophic microorganisms contribute to biogeochemical cycles in aquatic environments.
9. Identify the main spoilage microflora associated with fish and shellfish and discuss their impact on food safety.
10. What intrinsic and extrinsic factors most significantly affect seafood spoilage?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the health risks associated with filter-feeding bivalve shellfish and outline the depuration processes used to mitigate these risks.
12. Explain the various types of spoilage that can occur in fishery products, with specific examples of chemical, physical, and biological spoilage.
13. Outline the basic concepts of quality control in seafood safety and highlight the salient features of seafood quality.
14. Describe the major risk factors associated with seafood consumption, including biotoxins and other hazards.
15. What are HACCP, SSOP, and GMP, and how do they relate to seafood safety? Describe each briefly.
16. Discuss the methods used to evaluate fish freshness and quality, including at least one sensory and one instrumental method.
17. Explain the significance of isolation and enumeration of bacteria from aquatic environments in disease control.
18. Discuss the isolation and cultural characteristics of Vibrio sp. and its importance in aquaculture disease management.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Evaluate comprehensive management strategies for bacterial and viral diseases in aquaculture, incorporating examples of diagnostics, treatments, and preventive measures.
20. Critically assess the methods for pathological examination and production of disease-free seeds in aquaculture, discussing the evaluation criteria for healthy seeds and the effectiveness of these methods in disease prevention.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6EJ306 Sustainable Aquaculture Practices

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24

1. Describe how aquatic resources contribute to food security and livelihoods.
2. Discuss the ecological impacts of introducing exotic species into local aquatic ecosystems.
3. Explain the consequences of salinization of soil and water on local ecosystems.
4. Identify the effects of climate change on aquatic ecosystems.
5. What are some common water and land use conflicts encountered in aquatic resource management?
6. Compare the interests and impacts of aquaculture versus traditional fishing.
7. Why might communities resist aquatic resource projects?
8. How do international trade policies affect aquatic resource management?
9. Outline the importance of disease management in aquaculture.
10. What are the principles of sustainable aquaculture development?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the challenges of obtaining juveniles for aquaculture and potential solutions.
12. Detail the nutritional requirements essential for sustainable aquaculture.
13. Describe the design principles for open and closed water systems in aquaculture.
14. Explain the guidelines set by the FAO Code of Conduct for Responsible Fisheries.
15. Assess the role of bioremediation and biotechnology in advancing sustainable aquaculture practices.
16. Discuss the applications of renewable energy in aquaculture and their benefits.
17. How does trade and export influence the value addition of fishery products?
18. Identify the key challenges in implementing sustainable aquaculture and propose future directions for the industry.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Evaluate the impact of coastal aquaculture guidelines on maintaining ecosystem balance, detailing how these guidelines facilitate responsible aquaculture practices.

20. Analyze the potential of green technologies in aquaculture, such as water recycling and renewable energy solutions, to enhance sustainability and reduce environmental impacts.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6EJ307 Aquatic Ecology and Conservation in Aquaculture

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24

1. Describe the main components of an aquatic ecosystem.
2. What is ecological succession and how does it affect aquatic environments?
3. Explain the concept of ecological niche and how it relates to the carrying capacity of an ecosystem.
4. How are marine ecosystems classified ecologically?
5. Discuss the significance of biodiversity indices in studying aquatic ecosystems.
6. What is the IUCN categorization, and why is it important for endangered fishes?
7. How can freshwater resources and fish populations be conserved?
8. What is the ecological importance of mangrove vegetation?
9. Describe the structure and function of the benthic zone in marine environments.
10. How do ocean waters serve as a biological environment for marine life?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the distribution and population dynamics of plants and animals in marine environments.
12. Explain the adaptations of fauna in the littoral zones and their ecological implications.
13. Assess the effects of pollution on marine life and potential mitigation strategies.
14. Evaluate the impact of climate change on marine fisheries and the potential adaptation measures.
15. Discuss the role of in situ and ex situ conservation in the management of marine reserves.
16. What are Aquatic Protected Areas, and why are they critical for marine conservation?
17. How do modern computer tools like ECOPATH and ECOSIM contribute to ecosystem modeling and understanding trophic interactions?
18. Describe the ecosystem approach to fisheries management and its advantages over traditional management practices.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10**.**

19. Analyze the use of technology in fisheries conservation, including Turtle Excluder Devices (TED) and Bycatch Reduction Devices (BRD), and discuss their effectiveness and challenges.

20. Examine the regulatory measures and international agreements that govern deep sea fishing and their impact on sustainable fisheries management. Discuss the effectiveness of these measures in conserving marine biodiversity.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC 6EJ308Aquaculture Farm Management

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24

1. Describe the key sectors within the aquaculture industry.
2. List three types of aquafarms and describe one advantage of each type.
3. What are three critical parameters of water quality in aquafarms?
4. Explain the purpose of systems for water filtration and circulation in aquafarms.
5. Identify two common feed types used in aquafarms and discuss one feeding strategy.
6. What are the primary goals of disease prevention programs in aquaculture?
7. Describe a technological advance in aquaculture equipment that has improved farm productivity.
8. How does technology enhance operational efficiency in modern aquafarms?
9. What are the main principles of hatchery design?
10. Explain the significance of broodstock management in aquaculture.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the conditions necessary for successful larval rearing in aquaculture.
12. Outline best practices for sustainable aquaculture.
13. Describe strategies used in aquaculture to mitigate environmental impacts.
14. Explain the importance of national and international regulations in aquaculture management.
15. What are the benefits of obtaining certification for sustainable aquaculture practices?
16. Discuss the key elements that should be included in a business plan for an aquafarm.
17. Describe how market analysis informs marketing strategies in the aquaculture industry.
18. Explain the concepts and benefits of Integrated Multi-Trophic Aquaculture (IMTA) systems.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Develop a comprehensive discussion on how Integrated Multi-Trophic Aquaculture (IMTA) systems are designed for sustainability and productivity, including case studies of successful implementations.

20. Analyze the role of automation and remote monitoring technologies in improving the efficiency and productivity of aquafarms. Discuss the implications of these technologies for future aquaculture practices.

VIIth Semester

Major CORE

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC7CJ401Capture Fisheries

Credits 4

Section A

Maximum time 2 hours Maximum marks70

Answer all questions. Each question carries 3 marks. Ceiling 24

1. Discuss the significance of the marine fisheries sector in the Indian economy and its role in food security.
2. List the major inland water bodies in India and describe their fish fauna.
3. Explain the fishing methods used in the major estuarine systems in Kerala, India.
4. What is the Marine Fishing Regulation Act (MFRA), and how does it govern marine fisheries in India?
5. Describe global marine fish production trends as reported by the FAO.
6. What is the Deep Sea Fishing Policy of India and its objectives?
7. Discuss the impact of climate change on marine fisheries globally.
8. Identify the major fishing zones in India and their significance to the fishing industry.
9. List two important species of pelagic fish found in Indian waters.
10. Explain the regulatory framework for pelagic fisheries conservation in India.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe the diversity of pelagic fish species and their distribution within Indian waters.
12. Analyze the trends and features in the production of pelagic fisheries in India.
13. Discuss the conservation strategies implemented for pelagic fish stocks in India.
14. List the demersal fish species commonly found in Indian waters and describe their commercial importance.
15. Explain how demersal fisheries are managed and the sustainability practices involved.
16. Discuss the features and production trends of demersal fisheries in India.
17. Describe the challenges and management strategies of the crustacean fishery in India.
18. Analyze the molluscan fisheries in India, focusing on mussel, oyster, and clam fisheries.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Comprehensively evaluate the impact of international treaties and national policies on the management and sustainability of marine fisheries in India, including specific case studies.

20. Discuss the exploitation and management strategies of crustacean and molluscan fisheries in India, highlighting the economic importance, conservation challenges, and sustainable practices.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC7CJ402Instrumentation

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24

1. What are the key applications of advanced analytical techniques in scientific research?
2. Explain the benefits of integrating multiple laboratory instruments for comprehensive analysis.
3. Describe the process of instrument calibration and why it is crucial for accurate data analysis.
4. Discuss the importance of safety and maintenance practices for laboratory instruments.
5. What are the fundamental principles of spectrophotometry?
6. Compare the specific applications of UV-Visible and Infrared (IR) spectrophotometers.
7. How do Atomic Absorption (AAS) spectrophotometers function differently from other types?
8. What are some common troubleshooting strategies for spectrophotometers?
9. Outline the foundations of chromatography.
10. Identify two different types of chromatography and their unique applications.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe the working principle of Gas Chromatography and its applications in scientific research.
12. Explain how High-Performance Liquid Chromatography (HPLC) differs from traditional liquid chromatography.
13. Discuss the advanced techniques used in chromatographic separation and analysis.
14. What are the principles of electrophoresis and its significance in molecular biology?
15. Compare and contrast Agarose Gel Electrophoresis and Polyacrylamide Gel Electrophoresis.
16. Explain the role and benefits of Capillary Electrophoresis (CE) in analytical science.
17. What are the various microscopy techniques used in cellular biology, and how do they differ?
18. Discuss the specific applications of Electron Microscopy, including TEM and SEM, in scientific research.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a detailed analysis of how integrated instrument systems enhance the capabilities of a research laboratory, including examples of specific analytical problems that can be solved.
20. Discuss the advancements in chromatography and electrophoresis techniques and their impact on the field of genetic engineering and pharmaceuticals, providing examples of how these technologies have revolutionized the field.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC7CJ403Live Feed Culture

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. What is the importance of natural food in aquaculture, and how can live feeds be enriched and preserved?
2. Discuss the nutritional quality of commonly used fish food organisms in aquaculture.
3. Explain the use of periphyton in aquaculture and its benefits.
4. Describe the morphology of Artemia and its significance in aquaculture.
5. What are the life cycle stages and ecological importance of Artemia in natural environments?
6. Explain the procedures for Artemia cyst disinfection, decapsulation, and hatching.
7. Discuss the techniques involved in the pond production and harvesting of grown Artemia.
8. What are the uses of microalgae in aquaculture?
9. Identify major classes and genera of cultured algal species used in aquaculture.
10. Describe the methods for quantifying algal biomass in culture systems.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Detail the culture media, harvesting, and preservation techniques used for microalgae in aquaculture.
12. Explain algal mass culture techniques and the factors that influence their success.
13. Discuss the physical and chemical conditions required for optimal algal production.
14. Describe the nutritional value of microalgae and bacterioplankton when used as live feed.
15. Explain the general culture conditions for live feed organisms such as rotifers, cladocerans, and copepods.
16. Discuss zooplankton mass culture techniques and their application in aquaculture.
17. What are the methods and benefits of using resting eggs of rotifers and cladocerans in aquaculture?
18. Describe the culture conditions and benefits of nematodes and mesocosm systems in live feed production.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive overview of the steps involved in setting up and managing an Artemia culture system, from cyst activation to nauplii harvesting, including the challenges faced during the process.
20. Discuss the advancements in microalgal culture techniques, focusing on outdoor pond production, batch and continuous cultures, and their implications for sustainable aquaculture.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC7CJ404 Fisheries Economics and Extension

Credits 4

Section A

Maximum time 2 hours   Maximum marks70

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define economics and explain its scope in relation to individual demand.
2. What are the basic concepts of economics including goods, services, wants, and utility?
3. Explain the concepts of demand and supply with examples.
4. Describe the difference between market demand and value-based pricing.
5. What is elasticity of demand and the law of diminishing marginal utility?
6. How do supply and demand dynamics operate in fish markets?
7. Discuss the methods of price determination and different market structures.
8. Explain the role of international trade in fisheries.
9. What is a break-even analysis and why is it important in fisheries?
10. Describe variable cost, fixed cost, and total cost within the context of fisheries management.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Explain the concepts of junk cost, average cost, marginal cost, and opportunity cost in economic analysis.
12. Discuss the importance of farm planning and the differences between complete and partial budgeting in fisheries.
13. What is feasibility analysis in fisheries projects and why is it significant?
14. Describe the role of risk and uncertainty in fisheries economics, including sensitivity analysis methods like Monte Carlo Analysis.
15. Explain the concept of time value of money and its relevance to fisheries management.
16. Discuss the economic principles specifically applicable to aquaculture.
17. What impact do subsidies have on fisheries and aquaculture industries?
18. Describe various fisheries extension methods and factors influencing their selection and use.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Conduct a comprehensive analysis of the economic principles, including supply and demand, pricing strategies, and market structures, as they specifically apply to the fisheries sector. Include examples of how these principles affect fish market operations.

20. Evaluate the role and impact of fisheries cooperative development and institutional support in improving the socio-economic conditions of fishermen. Discuss specific contributions of organizations such as NFDB, MPEDA, and NABARD.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC7CJ405 Seed production and hatchery management

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Describe the process of induced breeding in fishes.
2. List three species for which seed production technology is essential.
3. What are the key considerations in managing a hatchery system?
4. Explain the function of recirculating systems in hatcheries.
5. What are the stages in the life cycle of crustaceans important for hatchery techniques?
6. Name two species of crustaceans that undergo induced breeding.
7. Describe the hatchery production technique for one species of shrimp.
8. How is the seed production of mud crabs carried out?
9. What are the general considerations in a marine fish hatchery?
10. List two types of live feeds used in hatcheries.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the importance and methods of spat collection for molluscs.
12. Explain induced maturation and spawning techniques in pearl oysters.
13. Outline the seed production techniques for Sea Bass.
14. Detail the hatchery technology used for lobsters.
15. Describe the mass production of algae and its significance in hatcheries.
16. Discuss Artemia production techniques and their importance in larviculture.
17. Explain the methods for culturing zooplankton for larviculture.
18. Assess the role of artificial feeds in larviculture and their impact on seed stock health.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Evaluate the comprehensive approach to marine seed production, focusing on the techniques and technologies for cultivable crabs, lobsters, and molluscs, including the challenges and advancements.
20. Analyze the role of water quality management in hatcheries, detailing techniques for monitoring and maintaining optimal water parameters, and discuss how these practices contribute to the success of breeding strategies and overall hatchery operations.

VIII th Semester

Major Core Courses

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8CJ406 Seaweed Cultivation and Utilization

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Describe the basic classification and morphology of seaweeds.

2. What are the ecological roles of seaweeds in marine ecosystems?
3. Discuss the factors that affect the distribution and habitat preferences of seaweeds.
4. Identify the major threats to seaweed biodiversity and outline sustainable management practices.
5. What are the basic considerations for site selection in seaweed farming?
6. Compare onshore, offshore, and IMTA systems in seaweed cultivation.
7. Describe sustainable harvesting techniques for seaweed.
8. What are the common challenges in seaweed cultivation and how can they be addressed?
9. How seaweeds are utilized in the food and nutraceutical industries?
10. What are the applications of bioactive compounds extracted from seaweeds in pharmaceuticals?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the use of seaweeds in agriculture, specifically focusing on their role as fertilizers and soil conditioners.
12. Explain how seaweed extracts are used in cosmetics and personal care products.
13. Describe the processes involved in producing biofuels and bioplastics from seaweed biomass.
14. Discuss the integrated uses of seaweeds in waste treatment, carbon sequestration, and habitat restoration.
15. How are seaweeds incorporated into animal feed in aquaculture and livestock industries?
16. Outline innovative products and emerging technologies that utilize seaweed.
17. Analyze the economic aspects and market trends affecting the seaweed industry.
18. Discuss the regulatory frameworks that impact seaweed cultivation globally.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive overview of the sustainability certifications applicable to seaweed farming and discuss how these certifications impact the industry practices and market access.
20. Evaluate the potential of seaweed biorefinery concepts and advances in genetic engineering of seaweeds to address challenges related to climate change mitigation and promote a circular economy in seaweed aquaculture.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8CJ407Major Deep Sea Fisheries

Credits 4

Section A

Maximum time 2 hours Maximum marks70

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define deep-sea fisheries and explain their significance to global food security.
2. Discuss the primary challenges facing deep-sea fishing today.
3. Describe the biodiversity characteristic of deep-sea ecosystems.
4. Explain the unique adaptations of organisms found in deep-sea environments.
5. What environmental impacts are associated with overfishing in deep-sea fisheries?
6. How is overfishing assessed in deep-sea environments?
7. Outline the key strategies for managing deep-sea fisheries.
8. Discuss the role of international cooperation in regulating deep-sea fisheries.
9. Describe the types of fishing gear and vessels used in deep-sea fishing.
10. What specialized equipment is utilized in deep-sea fishing operations?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the latest technological advancements in deep-sea trawling.
12. Explain how remote sensing is utilized in mapping and monitoring deep-sea fisheries.
13. Describe the applications of remote sensing in deep-sea fisheries research.
14. What are the primary conservation strategies for protecting vulnerable deep-sea species?
15. Discuss the importance of eco-friendly fishing practices in preserving deep-sea biodiversity.
16. Identify sustainable practices in deep-sea fishing and their effectiveness.
17. Provide examples from case studies that illustrate both successful and unsuccessful deep-sea fisheries management.
18. Analyze the future directions and emerging technologies in deep-sea fisheries research.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Conduct a comprehensive analysis of deep-sea fishing technologies and conservation strategies, focusing on how they contribute to sustainability and what improvements could be made based on recent technological advancements.

20. Evaluate India's deep-sea fishing resources, policies, and management strategies, discussing how these align with global best practices in fisheries management and what steps can be taken to enhance the sustainability of its deep-sea fisheries.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8CJ408 Fish Population Dynamics

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define the basic concepts of stock, recruitment, growth rate, and mortality rate in fisheries science.
2. Explain the importance of Stratified Random Sampling in fisheries assessments.
3. What is Maximum Sustainable Yield (MSY) and how is it calculated in fisheries management?
4. Discuss the challenges and limitations of applying MSY to fisheries management.
5. Describe the parameters involved in calculating fish growth using the VBGF equation.
6. What are the principles used to estimate growth parameters in fish population dynamics?
7. Explain the different types of mortality in fish populations and how they are estimated.
8. Describe how gear selectivity influences recruitment in fisheries.
9. How are analytical models like cohort dynamics used in fisheries assessment?
10. What is the purpose of surplus production models in fisheries management?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the Virtual Population Analysis method and its application in fish stock assessments.
12. Explain the Thompson and Bell model for fishery predictions and its significance.
13. Describe the Yield per Recruit and Relative Yield per Recruit models.
14. What are the features of holistic models like Schaefer's and Fox's models in fisheries?
15. Discuss the use of software tools such as FISAT and Monte Carlo simulations in fisheries assessments.
16. How does the R program facilitate the application of statistical methods in fisheries?
17. Explain how life history strategies impact fish population dynamics and management.
18. Discuss the impact of climate change on fish populations and fisheries management.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive analysis of how technological advancements and software applications have transformed fisheries assessments and management, with specific references to predictive and analytical models.

20. Evaluate the ecological foundations of fish population dynamics, focusing on the effects of reproductive biology, climate change, habitat usage, and predator-prey interactions on population dynamics and fisheries management.

VIII Semester

AQC8CJ489 Research Methodology

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8CJ489 Research Methodology

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define the different types of research: Pure, Applied, and Action Research.
2. What are the primary kinds of research, such as Diagnostic, Descriptive, Exploratory, and Explanatory?
3. Discuss the key aspects of research ethics, including both animal and human ethics.
4. Explain the importance of biosafety in research.
5. How is a research problem identified and selected?
6. What are the goals of conducting a literature search and review?
7. Describe the process of formulating and testing a hypothesis.
8. Outline the steps involved in preparing and submitting a research proposal to funding agencies.
9. What is the need for research design in scientific studies?
10. Discuss the features of good research design.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe the different types of research design, including descriptive, case control, cohort, cross-sectional, and longitudinal designs.
12. Explain the basic principles of experimental design.
13. What are Completely Randomized Design (CRD) and Quasi-Experimental designs?
14. Discuss the various methods of data collection in research, including the differences between primary and secondary data.
15. Describe the sampling techniques used in scientific research.
16. Explain the process of data analysis, including tabulations, classifications, and interpretations.
17. Discuss the role of statistics in research and its application in data analysis.
18. Outline the structure and components of a typical research thesis.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive analysis of how to structure an academic research paper, including the roles of authors, guides, and co-authors, and discuss the various components of research articles. Include an overview of how conference papers and project reports differ from typical research papers.

20. Evaluate the process of collecting literature for research, focusing on the use of digital libraries and internet resources like Google Scholar and PubMed. Discuss the advantages and challenges of using open-access journals and other virtual sources in research.

VIII th Semester

Major Electives

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8EJ401Endocrinology of Fish

Credits 4

Section A

Maximum time 2 hours   Maximum marks70

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define endocrinology and explain its significance in aquaculture.
2. Describe the different types of hormones and their chemical structures.
3. Explain how hormones interact with receptors and the role of signaling pathways in fish.
4. Discuss the concept of comparative endocrinology and how hormonal systems vary among fish species.
5. What are the roles and regulation mechanisms of growth hormones in fish?
6. Describe the hormonal control of reproductive cycles and behaviors in fish.
7. How do thyroid hormones influence metabolism and development in fish?
8. Discuss the effects of cortisol on fish health and disease resistance.
9. Explain how hormones adapt to environmental stressors in fish.
10. What are endocrine disruptors and how do they impact fish health?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe how photoperiod and seasonal changes affect hormone regulation in fish.
12. Discuss techniques used in aquaculture to manipulate hormonal levels for enhanced breeding.
13. Provide examples from case studies that demonstrate successes and failures in hormonal treatments.
14. Discuss future trends in hormonal research within the field of aquaculture.
15. Explain the neuroendocrine control systems in fish and their importance.
16. Describe practical applications of hormone assays in aquaculture and their interpretation.
17. Discuss how diet can be used to modulate hormonal responses in fish.
18. Explain the role of hormonal understanding in minimizing stress during handling and transport of fish.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a detailed analysis of how hormone therapies are applied in fish farming, including the considerations necessary for their successful application, and discuss the impact of these therapies on fish farming sustainability.

20. Evaluate the impacts of climate change on hormonal adaptation in fish, discussing how biotechnological interventions could aid in mitigating these impacts and the sustainability and ethical considerations involved.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8EJ402 Fish Immunology

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Describe the basic components of the immune system in vertebrates.
2. Explain the key organs and cells involved in the immune response of fishes and shellfish.
3. How do environmental factors influence fish immunity?
4. Discuss the characteristics of the immune response in invertebrates.
5. What are the different types and functions of immunoglobulins in fish?
6. Explain the concept and importance of monoclonal antibodies.
7. Describe the production and primary applications of immunoglobulins in aquaculture.
8. What are immunostimulants and how do they modulate immune responses in fish?
9. List the different types of immunity observed in fish.
10. What roles do T-cells play in the immune response of fish?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the various types of immune responses in fish and their functional significance.
12. Explain the process of cell-mediated immunity and its components in fish.
13. Describe the principles of humoral immunity and the roles of B-cells, antigens, and antibodies.
14. What antimicrobial and antitumor substances are found in fish, and how do they function?
15. How does the immune system respond to infection and inflammation in aquatic organisms?
16. Discuss the components and functions of the complement system in fish.
17. Explain how complement activation is regulated in fish and its effects on health.
18. Outline the principles of vaccination in fish and describe current immunization strategies.

Section C

Answer any one question. Each question carries 10 marks. 10X1=**10.**

19. Provide a detailed analysis of the immune responses to parasitic infections in fish, including the role of inflammation and hypersensitivity reactions, and discuss how this knowledge can be applied to develop effective disease control strategies.

20. Discuss the advancements in immunological techniques such as immunohistochemistry, ELISA, and flow cytometry, and their applications in studying fish immunity and managing disease outbreaks.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8EJ403 Organic Aquaculture

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define organic aquaculture and explain its core principles.
2. Discuss the history and global development of organic aquaculture.
3. Describe the regulatory framework for organic aquaculture certification both domestically and internationally.
4. Compare and contrast organic and conventional aquaculture practices.
5. List suitable species for organic aquaculture, including finfish, shellfish, and seaweed.
6. What are the key aspects of organic broodstock management and selection?
7. Describe hatchery and nursery operations specific to organic aquaculture.
8. What are sustainable stocking densities and carrying capacities in organic aquaculture?
9. Explain how feed is formulated and sourced in organic aquaculture systems.
10. Discuss organic nutrient sources and fertilization strategies used in organic aquaculture.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. How is water quality maintained in organic aquaculture systems?
12. Outline disease prevention strategies used in organic aquaculture.
13. Describe non-chemical parasite control methods utilized in organic aquaculture.
14. Explain the importance of maintaining fish health and resilience in organic aquaculture.
15. Identify the water quality parameters crucial for organic aquaculture.
16. Discuss monitoring and maintenance of optimal water quality conditions in organic aquaculture.
17. Describe aeration and biofiltration techniques used in organic aquaculture systems.
18. What does a biosecurity plan for organic aquaculture operations entail?

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Evaluate the economic feasibility and profitability of organic aquaculture, discussing the integration of organic practices with ecosystem health and the minimization of environmental impacts. Include examples of successful organic aquaculture operations and discuss their business models.

20. Develop a comprehensive marketing strategy for organic aquaculture products. Discuss how regulatory frameworks, permitted inputs, and practices such as traceability and labeling play a role in shaping these strategies, supported by case studies that highlight the challenges and future potential of organic aquaculture.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8EJ404 Fisheries Oceanography

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Describe the salient features of the world's oceans.
2. Discuss the oceanographic features unique to the Arabian Sea, Bay of Bengal, and Andaman Sea.
3. What is the elemental composition of seawater?
4. Explain the chemical and physical properties of seawater, such as temperature, salinity, and pressure.
5. Describe the physico-chemical features of the marine environment including waves.
6. How do tides, currents, and waves influence marine life and habitats?
7. Discuss the impact of monsoon cycles on the marine environment.
8. What are upwelling and mud banks, and how do they affect marine ecosystems?
9. Define zonation of the sea and explain its ecological importance.
10. Describe the adaptations of organisms in the intertidal environment.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Explain the biological divisions of the sea and their significance in marine ecology.
12. Discuss the topographic features of the deep ocean and the adaptations of deep-sea organisms.
13. Identify the major populations in the oceans such as phytoplankton, zooplankton, benthos, and nekton.
14. Describe marine food chains and food webs, highlighting their role in marine ecology.
15. Explain the basics of marine ecology and trophic dynamics.
16. Discuss the El Niño Southern Oscillation (ENSO) and its impact on marine ecosystems.
17. How does upwelling affect fisheries?
18. Evaluate the impacts of climate change on fisheries and marine biodiversity.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive analysis of how remote sensing and satellite oceanography are used in oceanographic sampling and data collection, including their benefits and limitations. Discuss how these methods contribute to sustainable fisheries management.

20. Discuss emerging technologies in oceanographic research and their application in fisheries management. Include specific case studies that illustrate their impact on enhancing our understanding of marine ecosystems and improving resource management strategies**.**

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8EJ405 Aquatic Pollution and Toxicology

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Define water pollution and list the types, sources, and impacts of water pollutants.
2. What are the key water quality parameters like BOD and COD, and why are they important?
3. Describe a case study that investigates the impacts of water pollution.
4. Explain the differences between primary, secondary, and tertiary wastewater treatment processes.
5. What is toxicity in environmental science, and what are toxicants?
6. How do toxicants enter the environment?
7. Discuss the cycles and residence times of toxicants in the environment.
8. Describe the toxicity of specific contaminant groups such as heavy metals or pesticides.
9. What is the purpose of toxicity testing in environmental science?
10. Explain the principles behind toxicity testing.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the methods and importance of in vitro toxicity testing.
12. Describe the procedures and significance of in vivo toxicity testing.
13. What are the common approaches for monitoring environmental toxicity?
14. Explain the role of microbiological toxicity testing in assessing environmental health.
15. Discuss the use of biosensors and biomarkers in toxicity testing.
16. What are molecular markers of toxicity, and how are they used in ecotoxicology?
17. Describe emerging technologies in toxicity testing and their advantages over traditional methods.
18. How do toxicants affect biological communities and ecosystems**?**

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive analysis of the multilevel interactions of toxicants within an ecosystem, discussing concepts such as bioaccumulation, biomagnification, and the

sensitivity and resilience of ecosystems to toxic exposure. Include case studies to illustrate key points.

20. Discuss the role of emerging toxicants like microplastics and persistent organic pollutants in environmental changes. Evaluate the effectiveness of current environmental regulations and policies aimed at controlling these pollutants, and suggest improvements based on recent research findings.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC8EJ406 Fisheries business management

Credits 4

Section A

Maximum time 2 hours **Maximum marks70**

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Explain the basic functions of management within the context of fish business management.
2. What roles does a manager play in the administration of a fish business?
3. Describe the different types of fish businesses, focusing on fish capture and culture.
4. Discuss the distinctions between domestic and export seafood businesses.
5. What is the nature and purpose of planning in fisheries management?
6. Define 'Managing by Objectives' and its importance in fisheries management.
7. How is forecasting used in fish production and marketing?
8. Provide an overview of a case study from the seafood processing and export business.
9. What is the purpose of formal and informal organizations in the seafood industry?
10. Explain the concept of departmentalization and its strategies in the seafood industry.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe how an organizational chart helps in understanding the structure and process in seafood management.
12. Discuss the benefits and limitations of line and staff authority in the seafood industry.
13. Explain the concepts of decentralization and delegation of authority within a seafood business.
14. Describe the staffing and selection process techniques used in the seafood industry.
15. How does human resource development contribute to managerial effectiveness in the seafood industry?
16. What role does human resources play in promoting a culture of safety and compliance in the seafood industry?
17. Discuss methods used for assessing and enhancing employee performance in the seafood industry.
18. Provide insights from case studies on organizing in seafood production, including seafood processing and aquaculture operations.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Conduct a comprehensive analysis of leadership roles and human factors in the seafood business management, discussing how aligning individual and organizational objectives can enhance productivity and innovation. Include relevant theories such as Maslow's Hierarchy of Needs and their application in the workplace.

20. Evaluate the controlling systems and processes within the global fisheries environment, focusing on budgeting and technological tools for control. Discuss international management practices and provide case studies of effective global fisheries management.

Multi-disciplinary courses (MDC)

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC1FM105 Fish as Food: Nutrition and Beyond"

Credits 3

Maximum time 1 ½ hours　　　　　　　　　　　　　　　　　　　　　　Maximum marks50

Section A

Answer all questions, each question carries 2 marks

Ceiling 16

1. What are the key nutritional benefits of including fish in a balanced diet?
2. How do omega-3 fatty acids in fish contribute to health?
3. Name two essential minerals commonly found in fish.
4. Identify one major risk associated with fish consumption and a method to mitigate it.
5. Describe the role of fish in traditional diets around the world.
6. How does fish contribute to food security?
7. What is one major trend in global fish consumption?
8. List a challenge to maintaining sustainable fish populations.
9. Compare the nutritional advantages of fish to other protein sources.
10. Explain the impact of fish processing on nutritional value.

Answer all questions. Each question carries 6 marks

Ceiling 24

11. Discuss how fish consumption addresses nutritional deficiencies and contributes to a healthier diet.
12. Describe the concept of sustainable fish consumption and its importance to global food security.
13. What innovations in aquaculture are most promising for nutritional security?
14. How do policy and governance play a role in sustainable fisheries?
15. Evaluate the importance of certification and labeling in promoting sustainable fish consumption.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

16. Discuss the health benefits and risks of eating fish

17. Examine how sustainable fish practices impact food security.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

Second semester CUFYUGP examination

AQC2FM 106 Marine Biodiversity &Conservation
Credits 3

Maximum time 1 ½ hours Maximum marks50

Section A

Answer all questions, each question carries 2 marks

Ceiling 16

1. Describe two key physical properties of marine environments.
2. List two major chemical properties of seawater and their significance to marine life.
3. What are the primary components of a marine ecosystem's food web?
4. Briefly explain the concept of overfishing and its impact on marine biodiversity.
5. What are the main pollutants affecting marine environments? Give two examples.
6. Describe how climate change affects marine ecosystems.
7. Name two marine protected areas (MPAs) and explain their purpose.
8. What is habitat restoration in marine environments? Give one example of a technique used.
9. Explain the role of NGOs in marine conservation.
10. What is the importance of community-based conservation efforts in marine ecosystems**?**

Section B

Answer all questions. Each question carries 6 marks

Ceiling 24

11.Discuss the ecological roles of marine life forms and how they contribute to the stability of marine ecosystems.

12. Elaborate on the impacts of habitat destruction and alteration on marine biodiversity.
13. Describe the principles of marine conservation and how they are applied in managing marine ecosystems.
14. Analyze the effectiveness of international conservation agreements and policies in protecting marine biodiversity.
15. Discuss the challenges and future directions in marine conservation, focusing on emerging technologies and strategies.

Answer any one. Each question carries 10 marks

1X10 =10

16. Provide a detailed analysis of the role of national legislation and policies in marine conservation, including examples from specific countries.

17. Examine case studies of marine policy successes and failures, highlighting key lessons learned and their implications for future marine governance.

Skill Enhancement courses (SEC)

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC5FS112 Academic writing for life science students

Credits 3

Maximum time 1 ½ hours Maximum marks50

Section A

Answer all questions. Each question carries 2 marks. Ceiling 16.

1. Define the main purpose of academic writing in life sciences.
2. Describe the differences between passive and active voice in scientific writing.
3. What is the IMRaD format and how is it applied in structuring scientific documents?
4. Outline the basic ethical principles in scientific research and writing.
5. What are the key steps in conducting a literature review in life sciences?
6. Explain the importance of using reference management software in academic writing.
7. How can plagiarism be avoided in academic writing?
8. What is critical reading and why is it important for academic writing?
9. Describe the role of quantitative research writing in presenting and interpreting data.
10. What is thematic analysis and how is it used in qualitative research writing?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 24.

11. Discuss how to tailor scientific content for different audiences, such as academic and public.
12. Explain the significance of policy briefs and grant proposals in academic research.
13. Describe the techniques for using tables and figures effectively in scientific documents.
14. Discuss the importance of peer review in maintaining the quality of scientific publications.
15. Identify the characteristics and importance of different types of research journals.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

16. Provide a comprehensive analysis of the entire process of academic publishing from literature search to the submission and peer review of manuscripts. Include discussions on ethical considerations and the challenges posed by predatory journals.
17. Discuss the impact of digital tools on academic writing in life sciences, including the use of paraphrasing tools, plagiarism checking software, and the role of artificial intelligence. Reflect on how these tools might change academic writing practices and their potential ethical implications.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC6FS113Aquatic Specimen Preservation: Techniques and Practices for Museum Collections

Credits 3

Maximum time 1 ½ hours   Maximum marks50

Section A

Answer all questions. Each question carries 2 marks. Ceiling 16.

1. What is the significance of preserving aquatic specimens?

2. Discuss the historical importance of specimen preservation in museums.
3. Explain the basic principles of taxonomy and classification as they apply to aquatic specimens.
4. What are the ethical considerations in specimen collection and preservation?
5. Describe key elements in designing educational and engaging museum displays for aquatic specimens.
6. How do lighting and climate control impact the preservation of aquatic displays?
7. What role does technology play in creating interactive displays for aquatic exhibits?
8. What are the main considerations in maintaining live aquatic exhibits?
9. Describe the role of formalin and alcohol in the chemical preservation of aquatic specimens.
10. What is the importance of freeze-drying and cryopreservation techniques in specimen preservation?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 24.

11. Discuss the various embedding techniques using plastics and resins for aquatic specimens and the contexts in which each technique is most effective.
12. Explain the process and challenges of skeleton preparation, including cleaning and assembly.
13. Detail the methods and importance of tissue sampling and DNA preservation in aquatic specimen management.
14. Describe the process and significance of photographic documentation in the preservation of aquatic specimens.
15. Explain how molds and casts are created and their role in replicating aquatic specimens.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

16. Provide a comprehensive overview of advanced preservation techniques, including microscopic techniques, anoxic preservation, 3D scanning, digital preservation, and non-invasive imaging techniques. Discuss how each technique contributes to the field of aquatic specimen preservation and the particular challenges they address.
17. Analyze the processes involved in the preservation of large aquatic animals, incorporating case studies or examples that illustrate innovative approaches and technologies used in their

preservation. Include a discussion on the logistical and ethical challenges faced during such preservation efforts.

Value Added Courses for the Double main pathway

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC3FV108Ecotourism

Credits 3

Maximum time 1 ½ hours | Maximum marks50

Section A

Answer all questions. Each question carries 2 marks. Ceiling 16.

1. Define ecotourism and explain its foundational principles.
2. What are the key environmental impacts associated with ecotourism?
3. Discuss the socio-economic impacts of ecotourism on local communities.
4. Explain the ethical considerations and best practices for conducting ecotourism.
5. What is farm tourism in aquaculture, and why is it significant?
6. Describe how aquaculture farms can be managed to accommodate tourism.
7. Outline the key components of educational programs designed to inform visitors about aquaculture and environmental stewardship.
8. Provide examples of successful farm tourism operations within the aquaculture industry.
9. Explain the concept of aquatourism and list some activities involved.
10. What are the best practices for ensuring sustainable aquatourism?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 24.

11. Discuss how aquatic biodiversity is important for aquatourism and the conservation efforts that can support this.
12. Describe the role of community and cultural engagement in enhancing the sustainability of aquatourism.
13. Detail innovative conservation practices used in aquatourism, such as coral reef restoration or artificial reefs.
14. Explain the importance of eco-certification and regulation compliance in aquatourism.
15. Discuss the impacts of pollution from aquatourism activities and strategies for managing waste and plastics in aquatic environments.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

16. Provide a comprehensive analysis of the role of technology in marine tourism, including how it enhances visitor experiences, supports conservation efforts, and ensures safety and risk management. Include examples of technologies used in marine protected areas and their impact on tourism management.

17. Discuss the challenges and opportunities in ecotourism, focusing on innovative strategies for eco-friendly tourist facilities, community-led ecotourism development, and the integration of technology. Reflect on how these strategies can address future challenges and enhance the sustainability of ecotourism.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

AQC4FV110Environmental Impact Assessment

Credits 3

Maximum time 1 ½ hours Maximum marks50

Section A

Answer all questions. Each question carries 2 marks. Ceiling 16.

1. What is an Environmental Impact Assessment (EIA), and why is it important?
2. Describe the general process and methodology of an EIA.
3. List the main components of an EIA.
4. Explain the concepts of Cumulative and Strategic Environmental Assessment (SEA).
5. What are the key characteristics of aquatic ecosystems relevant to EIA?
6. How is the impact assessment conducted specifically in aquatic environments?
7. Discuss common mitigation and management strategies used in aquatic environmental impact assessments.
8. Provide an overview of a case study that involved an EIA of an aquatic ecosystem.
9. What are the environmental impacts associated with deep-sea ecosystems?
10. How does offshore development affect aquatic environments?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 24.

11. Detail the process of assessing coral reefs within the framework of EIA.
12. Describe the tools and models used for cumulative impact assessment in marine environments.
13. Discuss the methodologies for assessing water pollution during an EIA.
14. Explain the components and importance of fisheries impact assessment within an EIA.

15. Discuss the role of public participation in the EIA process, particularly focusing on its impact in sensitive aquatic environments.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

16. Develop a comprehensive EIA report outline for a proposed marine development project, detailing each step from baseline studies to impact assessment, including mitigation measures, monitoring, and compliance strategies. Incorporate elements of stakeholder engagement and scenario planning.

17. Evaluate the integration of innovative tools and strategies such as climate change considerations and adaptive management into the EIA process. Discuss how these elements can enhance the effectiveness of environmental assessments and ensure sustainable project outcomes. Include examples where these strategies have been successfully implemented.

Minor Course

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

Minor Course Group 1Aquaculture systems and Management

AQC1MN101Introduction to Aquaculture

Credits 4

Maximum time 2 hours **Maximum marks70**

Section A

Answer all questions; each question carries 3 marks Ceiling 24

1. Define aquaculture and provide a brief overview of its history globally.
2. What are the main contributions of aquaculture to food security?
3. List the basic principles that govern successful aquaculture operations.
4. Describe the difference between extensive and intensive aquaculture systems.
5. Name three key species in freshwater aquaculture and their cultivation methods.
6. What are the primary types of species cultured in marine aquaculture?
7. Explain the significance of ornamental fish culture in aquaculture.
8. What are some uses of algae and aquatic plants cultivated in aquaculture?
9. Identify the main nutritional requirements for aquaculture species.
10. What are some common diseases found in aquaculture species?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the major feed types and feeding strategies used in aquaculture.
12. Outline the steps involved in the prevention and treatment of diseases in aquaculture.
13. Describe the biosecurity measures necessary for aquaculture facilities.
14. Explain how vaccinations contribute to health management in aquaculture.
15. Discuss the role of genetics in enhancing disease resistance in aquaculture species.
16. Analyze the impact of stress management on the health of aquaculture species.
17. Provide an example of a case study that involves managing a disease outbreak in an aquaculture setting.
18. What are the key environmental impacts associated with aquaculture?

Answer any one. Each question carries 10 marks

1X10 =10

19. Elaborate on the sustainable practices that can mitigate the environmental impacts of aquaculture. Include examples of how these practices are applied.
20. Discuss the role of regulation and policy in shaping sustainable aquaculture practices, focusing on both national and international frameworks.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

Minor Course Group 1Aquaculture systems and Management

AQC 2MN101 Aquaculture Disease Management

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks Ceiling 24

1. Briefly describe the role of health management in aquaculture.
2. List three common pathogens found in aquaculture systems.
3. What are the main routes of disease transmission in aquatic environments?
4. How do diseases impact aquaculture production?
5. Name two diagnostic techniques used in aquaculture.
6. What is the importance of epidemiology in aquaculture?
7. Describe the purpose of biosecurity measures in disease prevention.
8. Identify three bacterial diseases common in aquaculture.
9. What are the effects of environmental stressors on disease susceptibility in aquatic species?
10. Explain the concept of immunology and its relation to disease resistance in aquatic species**.**

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the role and effectiveness of viral disease management in aquatic species.
12. Describe the challenges of managing parasitic infections in aquaculture.
13. Explain how fungal diseases affect aquatic environments and the methods used for their control.
14. Discuss the impact of protozoan diseases on aquaculture and the strategies for their management.
15. Analyze the implications of emerging diseases in aquaculture and steps to mitigate their spread.
16. Provide an overview of chemotherapy and pharmacology applications in aquaculture.
17. Discuss the principles and applications of vaccination strategies in aquaculture.
18. Describe integrated disease management approaches and their benefits in aquaculture.

Answer any one. Each question carries 10 marks

1X10 =10

19. Elaborate on the role and effectiveness of quarantine procedures and biosecurity protocols in preventing disease outbreaks in aquaculture.
20. Discuss detailed case studies on disease outbreaks in aquaculture, including management strategies and outcomes.

B.Sc. Aquaculture Honours

(CUFYUGP) Degree Examinations

Minor Course Group 1Aquaculture systems and Management

AQC3MN201Aquaculture Production Systems

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Describe the different types of aquaculture systems commonly used.
2. Explain the key principles that underlie successful aquaculture production.
3. What are the major environmental factors that influence aquaculture operations?
4. Discuss sustainable practices that can be implemented in aquaculture production.
5. Describe the management techniques essential for effective pond culture systems.
6. What are the main operational aspects of cage culture systems in aquaculture?
7. Explain how stocking, feeding, and water quality are managed in pond and cage cultures.
8. Discuss the importance of disease management and biosecurity in pond and cage culture systems.
9. Provide an overview of Recirculating Aquaculture Systems (RAS) and their importance.
10. What are the key design components of a RAS?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Explain how water quality is managed in Recirculating Aquaculture Systems.
12. Discuss the strategies used to maintain fish health and biosecurity in RAS.
13. Describe the feeding and nutritional management practices in RAS.
14. What are the production processes for finfish and shellfish species in RAS?
15. Evaluate the economics and sustainability aspects of RAS.
16. Describe the principles and key concepts of Integrated Multi-Trophic Aquaculture (IMTA).
17. How are species selected and integrated within IMTA systems?
18. Discuss the environmental benefits and challenges associated with implementing IMTA systems.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Provide a comprehensive analysis of nutrient dynamics and bioremediation processes in Integrated Multi-Trophic Aquaculture systems, detailing how these processes contribute to sustainability and efficiency in aquaculture.
20. Discuss the implementation and management strategies of IMTA projects, including case studies that highlight practical applications and the results of such projects in real-world settings.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Minor)

Group 2 *Seafood Safety and Trade*

AQC1MN102 Introduction to Seafood Quality Control

Credits 4

Maximum time 2 hours   Maximum marks70

Section A

Ceiling 24

Answer all questions, each question carries 3 marks

1. Define seafood quality and mention two key factors that influence it.
2. Describe three types of spoilage that affect seafood.
3. What are the roles of sensory evaluation in seafood quality assessment?
4. Explain the importance of microbiological testing in maintaining seafood quality.
5. List two modern techniques used in seafood quality assessment and briefly describe their advantages.
6. What is HACCP and why is it crucial in seafood processing?
7. Explain the significance of packaging in seafood preservation.
8. Describe the impact of freezing on the quality of seafood.
9. What are consumer rights in the context of seafood safety and quality?
10. Name two international standards for seafood quality and briefly describe their purpose.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the chemical parameters important for assessing the quality of seafood.
12. How do canning and smoking contribute to the preservation of seafood? Provide details of each method.
13. Evaluate the role of modern preservation techniques compared to traditional methods in seafood processing.
14. Discuss the challenges of implementing quality control in seafood processing units.
15. Describe the process and benefits of certification in seafood quality management.
16. Analyze the role of sensory evaluation in detecting early signs of spoilage in seafood.
17. Compare and contrast the effectiveness of drying versus salting in seafood preservation.
18. Provide an overview of the legal implications of non-compliance with seafood safety regulations.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Develop a comprehensive plan detailing how a seafood processing plant could implement HACCP to ensure product safety and regulatory compliance.

20. Conduct a critical analysis of different seafood preservation methods discussed in the course, highlighting their pros and cons, and suggest improvements based on recent technological advancements.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Minor)

Group 2 *Seafood Safety and Trade*

AQC2MN102 Fundamentals of Seafood Trade

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Ceiling 24

1. Briefly describe the global seafood industry and its key players.
2. Discuss the economic impact of seafood trade on global economies.
3. Outline the seafood supply chain from harvest to market.
4. What are the main international trade policies affecting seafood trade?
5. Name key international regulations governing seafood trade.
6. Describe seafood trade regulations specific to any one country.
7. What are the roles of certification schemes like MSC and ASC in the seafood industry?
8. List the main procedures and documents required for exporting seafood.
9. What is the significance of the Indian seafood industry in global trade?
10. Name three key seafood products exported from India.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Explain the role of the WTO and Codex Alimentarius in seafood trade regulation.
12. Discuss the challenges faced by the Indian seafood export industry and potential opportunities for growth.
13. Describe the essential documentation and procedures for exporting seafood from India.
14. Explain the importance of cold chain management in the seafood trade.
15. Analyze the impact of market access requirements on international seafood trade.
16. Describe the logistics involved in the global seafood supply chain.
17. Discuss packaging and labeling standards critical for international seafood trade.
18. Identify and explain how to overcome trade barriers in the seafood industry.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Develop a comprehensive analysis of the export and import processes of seafood in India, detailing the regulatory framework and key logistical considerations.

20. Conduct a detailed risk assessment for entering a new international market in the seafood industry, considering trade barriers, market access requirements, and compliance with international standards.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Minor)

Group 2 *Seafood Safety and Trade*

AQC3MN202 Seafood Quality Management Systems

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Ceiling 24

1. Describe the key aspects of seafood quality management.
2. List three key physical attributes that affect seafood quality.
3. What are the biological factors that impact seafood quality?
4. Explain the role of Quality Management Systems (QMS) in maintaining seafood quality.
5. What is HACCP and why is it crucial in seafood quality management?
6. Describe the main elements of ISO 22000 in the context of seafood.
7. Outline the key guidelines provided by FSSAI for seafood safety.
8. Name two major regulations from the EU and USFDA that impact seafood safety.
9. How do Total Quality Management (TQM) principles apply to the seafood industry?
10. What are Good Manufacturing Practices (GMPs) and how do they ensure seafood quality?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the development and implementation of Sanitation Standard Operating Procedures (SSOPs) in seafood processing.
12. Describe techniques for quality control and assurance in seafood processing.
13. Explain the importance of inspection and auditing in maintaining seafood quality.
14. How is traceability of seafood products ensured through the supply chain?
15. Discuss the risks associated with seafood quality management and how they can be managed.
16. What are the best practices for documentation and record keeping in quality management systems?
17. Outline strategies for continuous improvement in seafood quality management.
18. Analyze a real-world case study on seafood quality management and compliance.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Develop a comprehensive plan detailing how a seafood processing facility can implement and maintain an HACCP plan, including necessary documentation and compliance measures.

20. Evaluate the role of third-party audits and certifications in enhancing seafood quality and safety, discussing the benefits and challenges faced by seafood processors.

Model Question paper

Vocational Minor Courses

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Vocational Minor)

Group 1 Commercial Production of Ornamental fishes

AQC1VN 101 Ornamental Fish Breeding Techniques

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks Ceiling 24

1. Provide an overview of the ornamental fish industry.
2. Why are breeding techniques important in the ornamental fish trade?
3. What is involved in broodstock selection and management?
4. Describe the essential features of a facility designed for ornamental fish breeding.
5. What are hormonal manipulation techniques for spawning induction?
6. Describe typical spawning behavior observed in ornamental fish.
7. List key water quality parameters that must be managed during larval rearing.
8. Name three common diseases found in ornamental fish breeding.
9. What are the main nutritional requirements for broodstock and fry?
10. Explain the importance of stress management in ornamental fish breeding.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the egg collection process and the factors that influence its success in ornamental fish breeding.
12. Elaborate on larval rearing techniques and feeding strategies used in ornamental fish breeding.
13. Describe the prevention and control measures for managing diseases in ornamental fish breeding.
14. What are the quarantine protocols for broodstock and fry, and why are they critical?
15. Explain the biosecurity practices implemented in ornamental fish facilities.
16. Discuss the role of health monitoring and disease surveillance in maintaining healthy ornamental fish populations.
17. Analyze market trends and demand in the ornamental fish trade.
18. Describe the sales channels and distribution networks commonly used in the ornamental fish industry.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Detail the strategies for branding and product differentiation in the ornamental fish industry, including how these strategies influence market positioning.
20. Develop a comprehensive emergency response plan for managing disease outbreaks in an ornamental fish breeding facility, including steps for prevention, intervention, and recovery.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Vocational Minor)

Group 1 Commercial Production of Ornamental fishes

AQC 2VN101Aquarium Systems and Management

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

1. Provide a brief overview of the aquarium industry.
2. What are the fundamental principles of aquarium design?
3. List three essential pieces of equipment for a basic aquarium setup.
4. What is aquascaping and why is it important in aquarium design?

5. Describe the role of biological filtration in maintaining water quality.
6. Explain the importance of water parameters in aquarium management.
7. How do filtration systems contribute to water quality?
8. What are the considerations for selecting freshwater species for an aquarium?
9. Describe basic feeding and nutrition requirements for common aquarium fish.
10. What are the legal considerations in managing aquarium species?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the steps involved in the nitrogen cycle within an aquarium setting.
12. Explain how to conduct water testing and what maintenance procedures are essential for aquarium health.
13. Discuss the compatibility of fish and invertebrates in marine aquariums.
14. Describe the social dynamics and behavior observed in aquarium fish.
15. What techniques are used for breeding and reproduction in captivity?
16. Explain the procedures for handling and acclimation of new fish into an aquarium.
17. Describe strategies for disease prevention and management in aquarium settings.
18. Discuss the importance of environmental enrichment for aquatic species in captivity.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Outline routine maintenance procedures for an aquarium and explain the rationale behind each step.
20. Develop a comprehensive emergency preparedness and response plan for aquarium systems, including steps to address common problems and equipment failures.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Vocational Minor)

Group 1 Commercial Production of Ornamental fishes

AQC3VN201Health Management in Ornamental Fish

Maximum time 2 hours Maximum marks70

Credits 4

Section A

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. What are the key principles of health management in ornamental fish?
2. Explain the importance of disease prevention in ornamental fish care.
3. Describe the basic anatomy and physiology of ornamental fish relevant to their health.
4. What are the initial biosecurity measures recommended for ornamental fish care?

5. How are common diseases in ornamental fish identified and classified?
6. Discuss the symptoms, causes, and transmission routes of common diseases in ornamental fish.
7. Provide an example from a case study on disease outbreaks in ornamental fish populations.
8. What is the impact of diseases on ornamental fish populations?
9. Describe diagnostic techniques used in ornamental fish health management.
10. How does water quality analysis aid in the diagnosis of diseases in ornamental fish?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Explain the role of bacteria, viruses, and parasites as pathogens in ornamental fish.
12. Discuss the treatment options available for managing diseases in ornamental fish, including the use of medications and antibiotics.
13. Describe alternative therapies used in ornamental fish health management.
14. How are bacterial diseases diagnosed and managed in ornamental fish?
15. Outline the diagnosis and management approaches for viral diseases in ornamental fish.
16. Explain the surgical interventions that can be employed in fish health management.
17. What are the biosecurity protocols for ornamental fish facilities?
18. Discuss the quarantine procedures for new fish arrivals in ornamental fish facilities.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Develop a comprehensive biosecurity plan for an ornamental fish facility. Include details on environmental management, integrated pest management approaches, and risk assessment and mitigation strategies to prevent disease outbreaks.
20. Create a detailed case study that discusses the implementation of health management practices in an ornamental fish facility. Include aspects such as disease diagnosis, treatment, prevention strategies, and the role of water quality management in maintaining fish health.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Vocational Minor)

Group 1 Commercial Production of Ornamental fishes

AQC8VN301Business Aspects of Ornamental Fish Trade

Maximum time 2 hours Maximum marks70

Credits 4

Section A

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. What are the key components of the global ornamental fish industry?
2. Discuss current market trends and demand factors in the ornamental fish trade.
3. Outline the legal and regulatory frameworks affecting the ornamental fish trade.
4. What are the ethical considerations and sustainability practices relevant to the ornamental fish trade?

5. How do branding and product differentiation impact the ornamental fish market?
6. Describe effective pricing strategies for ornamental fish.
7. What are the primary sales channels and distribution networks used in the ornamental fish trade?
8. Explain the role of customer relationship management in the ornamental fish industry.
9. What are the basic elements of business planning and strategy development in this industry?
10. Discuss the operational management and logistics challenges specific to the ornamental fish trade.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Describe the supply chain management strategies for ornamental fish businesses.
12. How does strategic planning and goal setting influence success in the ornamental fish trade?
13. Discuss inventory management and procurement strategies used in the ornamental fish industry.
14. Explain how human resource management and employee training are critical in ornamental fish trade operations.
15. What considerations are involved in designing the layout of an ornamental fish facility to optimize operations?
16. Detail the importance of quality control and assurance in maintaining the standards of ornamental fish.
17. Discuss the role of quality management systems and continuous improvement initiatives in the ornamental fish trade.
18. Explain financial planning and budgeting techniques relevant to the ornamental fish trade.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Develop a comprehensive business plan for an ornamental fish trade operation that includes market analysis, operational management, financial planning, and sustainability measures. Include specific strategies for risk management and insurance to safeguard business operations.

20. Analyze the impact of financial management practices, including cost analysis, profit optimization, financial reporting, and cash flow management on the sustainability and growth of an ornamental fish business. Discuss the implications of these financial practices on the long-term viability of the business.

B.Sc. Aquaculture Honours Degree Examinations October 2024

First semester CUFYUGP examination (Vocational Minor)

Group 2 Fish Processing Technology

AQC1VN102 Fundamentals of Fish Processing

Credits 4

Maximum time 2 hours | Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

1. Provide a brief overview of the fish processing industry.
2. Why is fish processing important in aquaculture?

3. Define three basic concepts or terminologies used in fish processing.
4. What are the key regulatory standards and safety measures in fish processing?
5. Describe one handling technique that helps maintain fish quality.
6. What role does temperature control play in fish preservation?
7. Name a common packaging material used in fish processing and its impact on fish quality.
8. Explain the principle behind fish smoking as a preservation method.
9. What are value-added products in the context of fish processing?
10. Describe one emerging trend in sustainable fish processing technologies.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the different methods used for fish filleting and portioning.
12. Explain the curing and drying techniques commonly used in fish processing.
13. Describe the freezing and refrigeration processes in fish preservation.
14. Outline the innovative methods for fish dehydration and freeze-drying.
15. How does high-pressure processing (HPP) enhance fish preservation?
16. Discuss novel approaches to fish fermentation and pickling.
17. Explain how nanotechnology is utilized in fish packaging and preservation.
18. Discuss the application and benefits of Hazard Analysis and Critical Control Points (HACCP) in fish processing.

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Provide a detailed explanation of the quality assessment parameters used in fish processing, including how they impact product quality.
20. Develop a comprehensive overview of quality assurance in fish processing, focusing on sensory evaluation techniques and the role of sensory panels.

B.Sc. Aquaculture Honours

CUFYUGP degree examination (Vocational Minor)

Group 2 Fish Processing Technology

AQC 2VN 102Seafood Safety and Quality Control

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions, each question carries 3 marks

Ceiling 24

1. What are the three types of hazards commonly found in seafood?
2. Explain the principle of Hazard Analysis and Critical Control Points (HACCP).
3. Describe one emerging challenge in seafood safety.

4. What is the importance of sensory evaluation in assessing seafood quality?
5. Name a chemical analysis technique used for seafood quality assessment.
6. Explain the role of microbiological analysis in seafood quality control.
7. What are biotoxins, and why are they significant in seafood safety?
8. List two sources of heavy metal contamination in seafood.
9. Describe one method for addressing microbial contamination in seafood processing.
10. What are allergen management practices in seafood handling**?**

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36 marks

11. Discuss the instrumentation and technology used in quality assurance for seafood.
12. Elaborate on the control measures for chemical contaminants in seafood.
13. Describe the challenges posed by emerging contaminants in seafood and potential solutions.
14. Explain advanced techniques used in seafood inspection and grading.
15. What are the key components of regulatory compliance and international standards in seafood safety?
16. Discuss the importance of sanitation and hygiene practices in seafood processing.
17. Explain risk communication strategies in the context of seafood safety.
18. How do traceability and product recall systems ensure seafood safety?

Section C

Answer any one. Each question carries 10 marks

1X10 =10

19. Provide a detailed analysis of the quality control measures in the seafood industry and how they help maintain product integrity.
20. Discuss the regulatory frameworks and standards critical to maintaining seafood safety and compliance in the international market.

B.Sc. Aquaculture Honours

CUFYUGP Degree examination (Vocational Minor)

Group 2 Fish Processing Technology

AQC3VN 202Value-Added Fish Products Development

Credits 4

Maximum time 2 hours Maximum marks70

Section A

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. Describe the concept of value addition in the fish processing industry.

2. Why are value-added products important for market competitiveness in the fish industry?
3. What are the key considerations in new product development for value-added fish products?
4. Discuss the types of packaging materials and methods used for value-added fish products.
5. Explain the smoking, curing, and drying methods used in fish processing.
6. Describe the techniques of marination, pickling, and seasoning in fish processing.
7. What role do fermentation and enzyme-based processes play in creating value-added fish products?
8. How can novel ingredients and flavors enhance the appeal of fish products?
9. Identify the benefits of incorporating smoked, marinated, and flavored variants into fish fillets.
10. Discuss the production and market appeal of fish cakes and nuggets.

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Explain the process and market for surimi and imitation seafood products.
12. Discuss the production and benefits of fish oil and omega-3 supplements.
13. What are fish meal and fish protein concentrates, and how are they utilized?
14. Describe the products derived from fish roe and their market significance.
15. Examine the potential uses and benefits of fish skin and collagen products.
16. How is fish by-product utilization an important part of waste management in the fish processing industry?
17. What innovative packaging and presentation techniques can be used for fish products?
18. Analyze consumer preferences and trends that influence the fish product market.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Develop a comprehensive market analysis for a new value-added fish product, from consumer preference study through market segmentation, target audience identification, product positioning, and penetration strategies. Include considerations for branding, packaging, and the use of digital marketing platforms.
20. Propose a detailed plan for a new fish-based snack product. Describe the development process from the formulation, including smokehouse experimentation, marination, curing, and extrusion processing, through to the quality assessment and sensory evaluation of the finished

product. Discuss how this product can be introduced into the market, highlighting the practical application during field visits to fish processing facilities.

B.Sc. Aquaculture Honours

CUFYUGP Degree examination (Vocational Minor)

Group 2 Fish Processing Technology

AQC8VN 302Advanced Packaging and Preservation Techniques

Credits 4

Maximum time 2 hours | Maximum marks70

Section A

Answer all questions. Each question carries 3 marks. Ceiling 24.

1. What are the main objectives of packaging in the context of product preservation?
2. Discuss various materials commonly used in packaging and their respective applications.
3. What are the key design considerations when developing packaging for food products?
4. Explain the importance of sustainability in packaging and give examples of sustainable packaging solutions.
5. Outline the basic principles of food preservation that influence packaging technologies.
6. Describe chemical methods used in food preservation and how they interact with packaging decisions.
7. What are some physical methods of preservation that can be enhanced through innovative packaging?
8. Discuss the role of biological and natural preservation methods in extending product shelf life.
9. Define active packaging and give examples of how it is used to extend the freshness of food products.
10. What is smart packaging technology, and how does it contribute to product safety and quality?

Section B

Answer all questions. Each question carries 6 marks. Ceiling 36.

11. Discuss the applications and benefits of vacuum packaging in the food industry.
12. Explain the concept of intelligent packaging systems and how they are used to monitor food quality.
13. Describe innovations in edible packaging and their potential impacts on the food packaging industry.
14. How does nanotechnology enhance the properties and functionalities of packaging materials?
15. Evaluate the environmental and practical benefits of biodegradable and bio-based packaging solutions.
16. Discuss the integration of packaging and preservation techniques to maximize food shelf life and quality.
17. Outline the regulatory and safety considerations that must be addressed in food packaging and preservation.
18. Explain the importance of quality assurance techniques in the packaging industry and how they are applied.

Section C

Answer any one question. Each question carries 10 marks. 10X1=10.

19. Develop a comprehensive case study on the effectiveness of Modified Atmosphere Packaging (MAP) in extending the shelf life of a specific food product. Include details on the technology, its implementation, and the observed benefits and challenges.

20. Provide a detailed analysis of current market trends and consumer preferences in food packaging, focusing on the demand for smart and sustainable packaging solutions. Discuss how these trends influence the development and marketing strategies of packaging technologies.