

MAHATHMA GANDHI UNIVERSITY

Priyadarshini Hills, Kottayam

SYLLABUS OF

B.Sc. AQUACULTURE

MODEL - III

2016

**REGULATIONS FOR UNDER GRADUATE PROGRAMMES UNDER CHOICE
BASED CREDIT SYSTEM 2016**

Preamble

Mahatma Gandhi University introduced Choice Based Credit and Semester and Grading System in colleges affiliated to the University from the Academic Year 2009-10, under **Direct Grading System**. Subsequently, the Kerala State Higher Education Council constituted a committee of experts headed by Prof. B Hridayakumari, to study and make recommendations for the improvement of the working of the Choice Based Credit and Semester System in colleges affiliated to the Universities in the State. The State Government accepted the recommendations of the Committee and the Syndicate and the Academic Council of the Mahatma Gandhi University has resolved to reform the existing CBCSS regulations. Accordingly Regulations for Under Graduate Programmes under Choice Based Course-Credit-Semester System and Grading, 2013, was introduced in the University from the Academic year 2013-14 onwards, under Indirect Grading System. The University Grants Commission, in order to facilitate student mobility across institutions within and across countries and also to enable potential employers to assess the performance of students, insisted to introduce uniform grading system in the Universities. The Academic Council of the Mahatma Gandhi University at its meeting held on 23rd May 2015 resolved to introduce the UGC Guidelines for Choice Based Credit System from the Academic Year 2016-17 onwards and the Syndicate of the University at its meeting held on 1st August 2015 approved the resolution of the Academic Council. Hence it becomes necessary to modify the existing CBCSS regulation as follows.

1. TITLE

- 1.1. These regulations shall be called “**REGULATIONS FOR UNDER GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM 2016**”

2. SCOPE

- 2.1 Applicable to all regular Under Graduate Programmes conducted by the University with effect from 2016 admissions, except for Professional and B.Voc programmes. Also applicable to Distance/Private Undergraduate Programmes with suitable modifications. Under Graduate Programmes in Management Studies are included as non-professional programmes. Provided that the existing CBCSS Regulations 2013 shall be applicable to

students who were admitted prior to the commencement of these Regulations and who are continuing their studies.

- 2.2 Examinations of the courses being run under the Distance/Private registration scheme shall be conducted annually.
- 2.3 The provisions herein supersede all the existing regulations for the Regular/Distance/Private Undergraduate programmes to the extent herein prescribed.

3. DEFINITIONS

- 3.1. '*Academic Week*' is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.
- 3.2. '*Choice Based Course*' means a course that enables the students to familiarize the advanced areas of core course.
- 3.3. '*College Coordinator*' is a teacher nominated by the College Council to co-ordinate the continuous evaluation undertaken by various departments within the college. He/she shall be nominated to the college level monitoring committee.
- 3.4. '*Common Course I*' means a course that comes under the category of courses for English and Environmental Studies & Human Rights and '*Common Course II*' means additional language.
- 3.5. '*Complementary Course*' means a course which would enrich the study of core courses.
- 3.6. '*Core course*' means a course in the subject of specialization within a degree programme.
- 3.7. '*Course*' comprises 'Paper(s)' which will be taught and evaluated within a programme.
- 3.8. '*Credit*' is the numerical value assigned to a paper according to the relative importance of the syllabus of the programme.
- 3.9. '*Department*' means any teaching department in a college.
- 3.10. '*Department Coordinator*' is a teacher nominated by a Department Council to co-ordinate the continuous evaluation undertaken in that department.
- 3.11. '*Department Council*' means the body of all teachers of a department in a college.
- 3.12. '*Faculty Advisor*' means a teacher from the parent department nominated by the Department Council, who will advise the student on academic matters.
- 3.13. '*Generic Elective (GE)*' means an elective paper chosen from any discipline/ subject, in an advanced area.
- 3.14. '*Grace Marks*' shall be awarded to candidates as per the University Orders issued from time to time.
- 3.15. '*Grade*' means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Paper/Course/ Semester/Programme.
- 3.16. '*Grade Point*' (GP) is the numerical indicator of the percentage of marks awarded to a student in a paper.

- 3.17. **'Institutional Average (IA)'** means average mark secured (Internal + external) for a paper at the college level.
- 3.18. **'Paper'** means a complete unit of learning which will be taught and evaluated within a semester.
- 3.19. **'Parent Department'** means the department which offers core course/courses within an undergraduate programme.
- 3.20. **'Programme'** means a three year programme of study and examinations spread over six semesters, the successful completion of which would lead to the award of a degree.
- 3.21. **'Semester'** means a term consisting of **90** working days, inclusive of tutorials, examination days and other academic activities within a period of six months.
- 3.22. **'University Average (UA)'** means average mark secured (Internal + external) for a paper at the University level.
- 3.23. **'Vocational Course' (Skill Enhancement Course)** means a course that enables the students to enhance their practical skills and ability to pursue a vocation in their subject of specialization.
- 3.24. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University.

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

- 4.1 Eligibility for admission, norms for admission and reservation of seats for various Undergraduate Programmes shall be according to the regulations framed/orders issued by the University in this regard, from time to time.
- 4.2 Students can opt for any one of the **Generic Elective Papers** offered by different departments of the college in fifth semester (subject to the availability of vacancy in the concerned discipline). If the number of applications exceeds the number of vacancies for a particular Generic elective paper, priority will be given to the students from the parent department (core subject). Selection of students in the generic elective paper will be done in the college based on merit and interest of the students.

5. DURATION

- 5.1 The duration of U.G. programmes shall be **6 semesters**.
- 5.2 There shall be two Semesters in an academic year, the 'ODD' semester commences in June and on completion, the 'EVEN' Semester commences after a semester-break of three days with two months vacation during April and May. (The commencement of first semester may be delayed owing to the finalization of the admission processes.)
- 5.3 A student may be permitted to complete the Programme, on valid reasons, within a period of 12 continuous semesters from the date of commencement of the first semester of the programme.

6. REGISTRATION

- 6.1. The strength of students for each programme shall be as per the existing orders, as approved by the University.
- 6.2. The college shall send a list of students registered for each programme in each semester giving the details of courses registered including repeat courses to the University in the prescribed form within **20** days from the commencement of the Semester.
- 6.3. Those students who possess the required minimum attendance during an academic year/semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next class.

7. SCHEME AND SYLLABUS

- 7.1. The U.G. programmes shall include **(a)** Common Courses I and II, **(b)** Core Course(s), **(c)** Complementary/Vocational Courses, and **(d)** Generic Elective Course (GE).
- 7.2. There shall be one Generic Elective paper in the fifth semester with a choice of one out of three elective papers from any programme or from the Physical Education department.
- 7.3. There shall be one Choice Based paper in the sixth semester with a choice of one out of three elective papers.
- 7.4. Credit Transfer and Accumulation system can be adopted in the programme. Transfer of Credit consists of acknowledging, recognizing and accepting credits by an institution for programmes or courses completed at another institution. The Credit Transfer Scheme shall allow students pursuing a programme in one University to continue their education in another University without break.
- 7.5. A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 40% are required for a pass for a paper. For a pass in a programme, a separate minimum of **Grade D** is required for all the individual papers. If a candidate secures **F Grade** for any one of the paper offered in a Semester/Programme, **only F grade** will be awarded for that Semester/ Programme until he/she improves this to **D Grade** or above within the permitted period. (See Clause 5.3)
- 7.6. Students who complete the programme with 'D' grade in the "Regulations for Under Graduate Programmes under Choice Based Credit System 2016" will have one betterment chance within 12 months, immediately after the publication of the result of the whole programme.
- 7.7. Students discontinued from previous regulations, CBCSS 2013, can pursue their studies in "Regulations for Under Graduate Programmes under Choice Based Credit System 2016" after obtaining readmission. These students have to complete the programme as

per “Regulations for Under Graduate Programmes under Choice Based Credit System 2016”.

- 7.8. Practical examinations will be conducted only at the end of even semesters for all programmes. Special sanction shall be given for those programmes which need to conduct practical examinations at end of odd semesters.

8. PROGRAMME STRUCTURE

Model I BA/BSc

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120
c	Credits required from Common Course I	22
d	Credits required from Common Course II	16
e	Credits required from Core course and Complementary courses including Project	79
f	Generic Elective (GE)	3
g	Minimum attendance required	75%

Model I/II B.Com

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120
c	Credits required from Common Course I	14
d	Credits required from Common Course II	8
e	Credits required from Core and Complementary/Vocational courses including Project	95
f	Generic Elective (GE)	3
g	Minimum attendance required	75%

Model II BA/BSc

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120

c	Credits required from Common Course I	16
d	Credits required from Common Course II	8
e	Credits required from Core + Complementary + Vocational Courses including Project	93
f	Generic Elective (GE)	3
g	Minimum attendance required	75%

Model III BA/BSc/B.Com

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120
c	Credits required from Common Course I	8
d	Credits required from Core + Complementary + Vocational Courses including Project	109
e	Generic Elective (GE)	3
f	Minimum attendance required	75%

9. EXAMINATIONS.

9.1 The evaluation of each paper shall contain two parts:

- (i) Internal or In-Semester Assessment (ISA)
- (ii) External or End-Semester Assessment (ESA)

9.2. The internal to external assessment ratio shall be 1:4. There shall be a maximum of **20** marks for internal evaluation and a maximum of 80 marks for external evaluation. Both internal and external marks are to be mathematically rounded to the nearest integer. For all papers (theory & practical), grades are given **on a 10-point scale** based on the total percentage of marks, **(ISA+ESA)** as given below:-

Percentage of Marks	Grade	Grade Point
95 and above	S Outstanding	10
85 to below 95	A ⁺ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B ⁺ Good	7

55 to below 65	B Above Average	6
45 to below 55	C Satisfactory	5
40 to below 45	D Pass	4
Below 40	F Failure	0
	Ab Absent	0

10. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a paper is calculated using the formula:-

$$CP = C \times GP, \text{ where } C \text{ is the Credit and } GP \text{ is the Grade point}$$

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:-

$$SGPA = TCP/TC, \text{ where } TCP \text{ is the Total Credit Point of that semester, ie, } \sum_1^n CPI;$$

TC is the Total Credit of that semester ie, $\sum_1^n Ci$, where n is the number of papers in that semester

Cumulative Grade Point Average (CGPA) is calculated using the formula:-

$$CGPA = TCP/TC, \text{ where } TCP \text{ is the Total Credit Point of that programme ie, } \sum_1^n CPI; TC$$

is the Total Credit of that programme, ie, $\sum_1^n Ci$, where n is the number of papers in that programme

Grade Point Average (GPA) of a Course (Common Course I, Common Course II, Complementary Course I, Complementary Course II, Vocational course, Core Course) is calculated using the formula:-

$$GPA = TCP/TC, \text{ where } TCP \text{ is the Total Credit Point of course ie, } \sum_1^n CPI;$$

TC is the Total Credit of that course, ie, $\sum_1^n Ci$, Where n is the number of papers in that course.

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

GPA	Grade
9.5 and above	S Outstanding
8.5 to below 9.5	A+ Excellent
7.5 to below 8.5	A Very Good
6.5 to below 7.5	B+ Good
5.5 to below 6.5	B Above Average
4.5 to below 5.5	C Satisfactory
4.0 to below 4.5	D Pass
Below 4.0	F Failure

11. MARKS DISTRIBUTION FOR EXTERNAL EXAMINATION AND INTERNAL EVALUATION

The external theory examination of all semesters shall be conducted by the University at the end of each semester. Internal evaluation is to be done by continuous assessment. For all papers (theory and practical) total marks of external examination is 80 and total marks of internal evaluation is 20.

Marks distribution for external and internal assessments and the components for internal evaluation with their marks are shown below:

11.1 For all theory papers

- a) **Marks of external Examination : 80**
 b) **Marks of internal evaluation : 20**

All the three components of the internal assessment are mandatory.

Components of Internal Evaluation of theory	Marks
Attendance	5
Assignment /Seminar/Viva	5
Test paper(s) (1 or 2) (1x10=10; 2x5=10)	10
Total	20

11.2 For all practical papers

- a) **Marks of external Examination : 80**
 b) **Marks of internal evaluation : 20**

All the four components of the internal assessment are mandatory.

Components Internal evaluation of Practical	Marks
Attendance	5
Test paper	5
Record*	5
Lab involvement	5
Total	20

*Marks awarded for Record should be related to number of experiments recorded and duly signed by the concerned teacher in charge.

11.3 For projectsa) **Marks of external Examination : 80**b) **Marks of internal evaluation : 20**

Components of External Evaluation of Project	Marks
Dissertation (External)	50
Viva-Voce (External)	30
Total	80

All the four components of the internal assessment are mandatory.

Components Internal Evaluation of project	Marks
Punctuality	5
Experimentation/Data collection	5
Knowledge	5
Report	5
Total	20

Attendance Evaluation**For all papers**

% of attendance	Marks
90 and above	5
85 – 89	4
80-84	3
76-79	2
75	1

(Decimals are to be rounded to the next higher whole number)

13. ASSIGNMENTS

Assignments are to be done from 1st to 4th Semesters. At least one assignment should be done in each semester for all papers.

14. SEMINAR/VIVA

A student shall present a seminar in the 5th semester for each paper and appear for Viva-voce in the 6th semester for each paper.

15. INTERNAL ASSESSMENT TEST PAPERS

At least one internal test-paper is to be attended in each semester for each paper. The evaluations of all components are to be published and are to be acknowledged by the candidates. All documents of internal assessments are to be kept in the college for two years

and shall be made available for verification by the University. The responsibility of evaluating the internal assessment is vested on the teacher(s), who teach the paper.

15.1 Grievance Redressal Mechanism

Internal assessment shall not be used as a tool for personal or other type of vengeance. A student has all rights to know, how the teacher arrived at the marks. In order to address the grievance of students, a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

Level 1: Department Level: The Department cell chaired by the HOD, Department Coordinator, Faculty Advisor and Teacher in-charge as members.

Level 2: College level: A committee with the Principal as Chairman, College Coordinator, HOD of concerned Department and Department Coordinator as members.

Level 3: University Level: A Committee constituted by the Vice-Chancellor as Chairman, Pro-Vice-Chancellor, Convener - Syndicate Standing Committee on Students Discipline and Welfare, Chairman- Board of Examinations as members and the Controller of Examination as member-secretary.

15.2 The College Council shall nominate a Senior Teacher as coordinator of internal evaluations. This coordinator shall make arrangements for giving awareness of the internal evaluation components to students immediately after commencement of I semester

15.3 The internal evaluation marks/grades in the prescribed format should reach the University before the 4th week of October and March in every academic year.

16. External Examination

The external theory examination of all semesters shall be conducted by the University at the end of each semester.

16.1 Students having a minimum of 75% average attendance for all the courses only can register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the University on valid grounds. This condonation shall not be counted for internal assessment. Benefit of attendance may be granted to students attending University/College union/Co-curricular activities by treating them as present for the days of absence, on production of participation/attendance certificates, within one week, from competent authorities and endorsed by the Head of the institution. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also. Those students who are not eligible even with condonation of shortage of attendance shall repeat the **semester** along with the next batch after obtaining readmission.

16.2 All students are to do a **project in the area of core course**. This project can be done individually or in groups (not more than five students) for all subjects which may be carried out in or outside the campus. Special sanction shall be obtained from the Vice-Chancellor to those **new generation programmes** and programmes on **performing arts**

where students have to take projects which involve larger groups. The projects are to be identified during the II semester of the programme with the help of the supervising teacher. The report of the project in duplicate is to be submitted to the department at the sixth semester and are to be produced before the examiners appointed by the University. External Project evaluation and Viva / Presentation is compulsory for all subjects and will be conducted at the end of the programme.

- 16.3** There will be no supplementary exams. For reappearance/ improvement, the students can appear along with the next batch.
- 16.4** A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.
- 16.5** A student who has completed the entire curriculum requirement, but could not register for the Semester examination can register notionally, for getting eligibility for promotion to the next semester.
- 16.6** A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the University examination for the same semester, subsequently.
- 17.** All programmes, courses and papers shall have unique alphanumeric code. Each teacher working in affiliated institutions shall have a unique identification number and this number is to be attached with the codes of the courses for which he/she can perform examination duty.

18. PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. She/he shall also submit a detailed scheme of evaluation along with the question paper.

A question paper shall be a judicious mix of very short answer type, short answer type, short essay type /problem solving type and long essay type questions.

Pattern of questions for external examination for theory paper

Pattern	Marks	Choice of questions	Total marks
Short Answer	2	9/12	18
Paragraph answer	4	6/9	24
Problem/ Short Essay	6	3/5	18
Long Essay	10	2/4	20
		20/30	80

Course structure for - BSc.AQUACULTURE

SEMESTER - I

	No	Course	Course Code	Title	Hr/ week	Credits
SEMESTER - I	1	Common course English			5	4
	3	Core I	AQ1CRT01	Biology of Fishes	3	2
	4	Core II	AQ1CRT02	Taxonomy of Aquatic Organisms	3	2
	5	Core III	AQ1CRT03	Aquatic Ecology	3	2
	6	Core Practical I	AQ1CRP01	Biology of Fishes	3	1
	7	Complementary Biochemistry			2	2
	8	Complementary Biochemistry Practical			2	1
	9	Complementary Zoology			2	2
		Complementary Zoology Practical			2	1
				Total	25	17

SEMESTER - II

	No	Course	Course Code	Title	Hr/ week	Credits
SEMESTER - II	1	Common course English			5	4
	2	Core IV	AQ2CRT04	Freshwater Aquaculture	3	2
	3	Core V	AQ2CRT05	Fishing technology	3	2
	4	CoreVI	AQ2CRT06	Biological Tools and Techniques and Research Methodology	3	2
	5	Core Practical II	AQ2CRP02	Freshwater Aquaculture, Fishing Technology and Biological Techniques	3	1
	6	Complementary Biochemistry			2	2
	7	Complementary Biochemistry Practical			2	1
	8	Complementary Zoology			2	2
	9	Complementary Zoology Practical			2	1
				Total	25	17

SEMESTER – III

No.	Course	Course Code	Title	Hr/week	Credits	
SEMESTER – III	1	Core VII	AQ3CRT07	Biostatistics and Computer Applications	4	3
	2	Core VIII	AQ3CRT08	Inland and Marine Fisheries	5	3
	3	Core IX	AQ3CRT09	Aquaculture	4	3
	4	Core Practical III	AQ3CRP03	Biostatistics and Computer applications (P)	2	2
	5	Training	AQ3CRFW1	Fresh water hatchery training	2	1
	6	Complementary Biochemistry			3	3
	7	Complementary Biochemistry Practical			1	1
	8	Complementary Zoology			3	3
	9	Complementary Zoology Practical			1	1
			Total	25	20	

SEMESTER – IV

No.	Course	Course Code	Title	Hr/week	Credits	
SEMESTER – IV	1	Core X	AQ4CRT10	Brackish water aquaculture and mariculture	4	3
	2	Core XI	AQ4CRT11	Aquaculture Nutrition	5	3
	3	Core XII	AQ4CRT12	Fish Genetics and Biotechnology	4	3
	4	Core Practical IV	AQ4CRP04	Fish Nutrition, Genetics and Biotechnology	2	2
	5	Training	AQ4CRFW2	Breeding of aquarium fish	2	1
	6	Complementary Biochemistry			3	3
	7	Complementary Biochemistry Practical			1	1
	8	Complementary Zoology			3	3
	9	Complementary Zoology Practical			1	1
			Total	25	20	

SEMESTER - V

No.	Course	Course Code	Title	Hr/week	Credits	
SEMESTER - V	1	Core 13	AQ5CRT13	Fishery Microbiology	6	4
	2	Core 14	AQ5CRT14	Fish Pathology	6	4
	3	Core practical 5	AQ5CRP05	Fishery microbiology and pathology	3	3
	4	Core practical 6	AQ5CRP06	Aquafarm management	3	3
	5	OJT	AQ5CROJ	On the job training	4	5
	6	Generic Elective	AQ5GET1 AQ5GET2 AQ5GET3	1. Hatchery Technology 2. Fish Preservation Techniques 3. Value Added Fishery Products	3	3
Total				25	22	

SEMESTER – VI

No.	Course	Course Code	Title	Hr/week	Credits	
SEMESTER – VI	1	Core 15	AQ6CRT15	Aquaculture Management	6	4
	2	Core 16	AQ6CRT16	Aquaculture Engineering	6	4
	3	Core 17	AQ6CRT17	Fisheries Economics and extension	5	4
	4	Core practical - 7	AQ6CRP07	Fish processing technology and quality control	2	2
	5	Core Practical - 8	AQ6CRP08	Water and Soil Quality Parameters	2	2
	6	Project work*	AQ6CRPR			3
	7	Study tour**	AQ6CRST			1
	8	Core Elective	AQ6CBT1 AQ6CBT2	Choice Based Paper – II 1.Fishery by products 2.Aquaculture and Management of Ecosystems	4	4
Total				25	24	

Course structure for BSc. Aquaculture

Semester – I

No	Course	Course Code	Title	Hr/week	Credits
1	Common course English			5	4
3	Core I	AQ1CRT01	Biology of Fishes	3	2
4	Core II	AQ1CRT02	Taxonomy of Aquatic Organisms	3	2
5	Core III	AQ1CRT03	Aquatic Ecology	3	2
6	Core Practical I	AQ1CRP01	Biology of Fishes	2	1
7	Complementary Biochemistry			2	2
8	Complementary Biochemistry Practical			2	1
9	Complementary Zoology			2	2
	Complementary Zoology Practical			2	1
			Total	25	17

Semester I

Course code - AQ1CRT01

Biology of fishes

Total hours - 36

Credits – 2

Module 1: Food and Feeding (10 Hrs)

Food and feeding habits – herbivores, carnivores and omnivores. Feeding behaviours- Carnivores - macrophagous feeding, microphagous feeding, benthophagous, planktivores- Feeding adaptations. Digestion-General morphology of alimentary canal of herbivores ,carnivores and omnivores; -digestive system and process of digestion in fish, Prawn and Mussels (type: Mullet, *Penaeus indicus*, freshwater mussel) Methods employed in the study of gut content analysis - occurrence method, numerical method, volumetric, gravimetric and point method -relative gut length-gastro-somatic index. Age and growth – Techniques used in the study of growth- Use of scales and otoliths-Tagging- Length - weight relationship.

Module 2: Circulation and Respiration (8 Hrs)

Respiratory system – General description of respiratory organs in fish (Types: Shark and Mullet), Aquatic respiration, Respiratory gases, Gaseous exchange. Adaptations of air breathing fishes. Respiration in crustaceans and molluscs. Cardio vascular system – General features of heart, Circulatory system and oxygen transport in fishes (Type: shark and mullet), crustaceans(type –*Penaeus indicus*) and molluscs (type-freshwater mussel).

Module 3: Reproduction and Endocrinology (9 Hrs.)

Structure of ovary and testes in fish, Development of primary and secondary sexual characteristics. Sexual dimorphism in fishes and crustaceans. Maturation and spawning in fishes, Factors affecting maturation and spawning. Fecundity, Condition factor, Size at first

maturity. Oviparous, Viviparous and Ovo-viviparous fishes. Parental care and breeding. Endocrine organs in fishes and crustaceans. Role of hormones in reproduction and moulting in crustaceans. Biological clocks- diurnal, lunar, circadian and tidal rhythms. Migration in fishes – anadromous and catadromous, homing, instinct and orientation.

Module 4 : Excretion, Osmoregulation and Sense organs (9 Hrs)

Structure of teleost kidney, Kidney function in marine and freshwater teleost. Osmoregulation in freshwater Teleost, Marine Teleost and Elasmobranch. Sense organs in fishes – Organs of smell, Taste buds, Lateral line system, Ampulla of Lorenzini. Sound production in fishes. Specialized organs in fishes – Electric organs, Poison glands. Colouration and Bioluminescence. Sense organs in crustaceans and molluscs. Buoyancy in fishes - Swim bladder and mechanism of gas secretion.

Course code - AQ1CRT02

Taxonomy of Aquatic Organisms

Total hours - 36

Credits – 2

Module 1: Introduction to Taxonomy (12Hrs)

Importance of Taxonomy- Kinds of classification- Phenetic, natural, cladistics, evolutionary and omniscient classification. Components of classification; Concept of species; Kinds of species-allopatric, sympatric, insular, panmictic and apomictic, and polytypic species. Taxonomic procedures - collection and preservation -methods of identification; Zoological Nomenclature - International Code of Zoological Nomenclature; kinds of names-nomen nudum, tautonyms, synonymy, homonymy. Typification, type and its kinds - primary types e.g allotype, holotype, lectotype and paratype

Module 2: Taxonomy of fishes (12Hrs)

Basic methods used in taxonomic studies -morphometric, meristic, anatomical, colour patterns, karyotypes and biochemical characteristics. Advances in taxonomy at molecular level. Position of fishes in phylum chordata. General features and outline classification of hagfish and lamprey, Shark and Chimaera, lung fish and Latimeria, herrings and sardines, carps and catfishes, mullets and sea bass, pearl spot and Climbing perch, puffers and Molas.

Module 3: Taxonomy of Crustacea (6Hrs)

Classification of major crustaceans upto orders; Species of Decapod crustaceans; external features used for taxonomic identification of *P. indicus* , *Scylla serrata* and *Panilurus homarus*.

Module 4: Taxonomy of Mollusca (6Hrs)

Classification of phylum mollusca upto orders. General features of gastropods, bivalves and cephalopods. Taxonomic features of Mussels, oyster, clams and scallops.

Aquatic Ecology

Course code - AQ1CRT03

Total hours - 36

Credits – 2

Module 1: Aquatic Ecosystem (6 Hrs)

Introduction, Types of freshwater ecosystems – Lotic and Lentic, Working of an ecosystem - energy flow, Productivity of water bodies – Primary, secondary, tertiary- Factors affecting primary production, Significance of a toxic substances to the food web, Bio concentration, Bio magnification, Aquatic Pollution.

Module 2 : Pond Ecology (6 Hrs)

Introduction, Types of ponds, Zones of fresh water ponds, Abiotic and biotic components of pond ecosystem, Limiting factors in a pond community, Fundamentals of pond ecology – Habitats in the pond community, Food webs and chains, Ecological make up of a pond.

Module 3 : Riverine Ecology (6 Hrs)

Introduction, Characteristics of lotic habitat, Adaptations of lotic animals, River zonation, Major river systems in India, Rivers of Kerala, Threats and management, Problems encountered in fisheries development of major rivers.

Module 4 : Lacustrine and Reservoir Ecology (6 Hrs)

Introduction, Classification of lakes, Zonation of lakes, Stratification in lakes, Biological communities of lakes, Major lakes and reservoirs in India, Lakes and reservoirs in Kerala, Problems encountered in fisheries development, Effects of dams.

Module 5 : Marine, Estuarine and Brackish water Ecology (12 Hrs)

Introduction, Characteristics of marine habitat, Hydrologic cycle, Zonation of marine habitat. Adaptations of marine animals, Coral reefs - Importance and threats, Classification of estuaries, Major estuaries, Ecology of estuarine and brackish water systems, Issues and challenges of management of brackish water systems, Problems encountered in fisheries development of major estuaries.

Core practical – 1

Course Code - AQ1CRP01

Practical

Taxonomy, Fishery Biology and Ecology

1. Dichotomous Key Identification of selected commercial inland and marine species (6 specimens)
- 2 Identification of larvae of cultivable fishes (Catla,Rohu,Mullet)
3. Identification of larval stages of crustaceans and molluscs.(Nauplius, Mysis, Zoea, megalopa, D-larva, Glochidium, Trochophore)
4. Sampling and Gut Content Analysis of fish (Points method and Occurrence method)
5. Identification of scale types and fins (Cycloid, Ctenoid, Placoid)
6. Mounting of appendages of Prawn (*Penaeus indicus*)
7. Dissection - alimentary canal of fish (Sardine/Mullet)
8. Dissection- alimentary canal/nervous system of prawns
9. Fecundity estimation in fish (Sardine/mullet)
10. Estimation of gonado-somatic index & determination
11. Construction of Food Web / Food Chain (Pond)
- 12. Harbour visit and Report submission (Compulsory)**

Semester – II

No	Course	Course Code	Title	Hr/week	Credits
1	Common course English			5	4
2	Core IV	AQ2CRT04	Freshwater Aquaculture	3	2
3	Core V	AQ2CRT05	Fishing technology	3	2
4	Core VI	AQ2CRT06	Biological Tools and Techniques and Research Methodology	3	2
5	Core Practical II	AQ2CRP02	Freshwater Aquaculture, Fishing Technology and Biological Techniques	3	1
6	Complementary Biochemistry			2	2
7	Complementary Biochemistry Practical			2	1
8	Complementary Zoology			2	2
9	Complementary Zoology Practical			2	1
			Total	25	17

Freshwater Aquaculture

Course code – AQ2CRT04

Total hours - 36

Credits – 2

Module 1 : Freshwater Fish Culture (9 Hrs)

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

Module 2 : Culture of Prawns, Molluscs and Frogs(9 Hrs)

Cultivable species of freshwater prawns and their biology – culture of *Macrobrachium rosenbergii*. Important freshwater molluscs of Kerala. Freshwater pearl culture – Present status of freshwater pearl culture and production in India. Species of frogs cultured.

Module 3: Systems in Aquaculture (9 Hrs)

Fish culture in ponds, cages and pens, raceways, indoor tanks, canals, silo culture, sewage-fed fish culture. Monoculture, polyculture, composite fish culture. Integrated fish farming with duck, pig, poultry, livestock, rice.

Module 4 : Aquaponics(9 Hrs)

History and Developments in aquaponics; Principle and functioning. Comparison of food production methods; Benefits of RAS; System types; System Components; System design; System installation and maintenance

Course code – Fishing technology

Fishing Technology

Total hours - 36

Credits – 2

Module 1: Fishing Crafts (10Hrs.)

Different types of fishing crafts in India- inland and marine – traditional, motorized and mechanized, trawlers, gill netters, purse seiners, long liners, trollers, deep sea vessels. Boat building materials – types (preparation, seasoning, preservation), advantages & disadvantages.

Module 2: Fishing Gears (10Hrs.)

Traditional fishing gears of Kerala; Fishing gear materials - natural and synthetic, yarn numbering systems, types of knots, knotless netting, meshes, braiding, shaping, creasing, baiting, fly-meshing, tailoring; Mounting of webbing – different methods, hanging coefficient, take up ratio; Modern commercial fishing methods- Operation and classification of trawling, purse seining, lampara net fishing, gill netting, line fishing. Squid jigging. Fishing accessories- hooks, floats, sinkers and ropes.

Module 3: FAD's, Artificial Reefs, Fish Finding Devices and Conservation (7 Hrs.)

Fish aggregating devices and artificial reefs; Impact of artificial reefs on fish stock improvement; Turtle Exclusion Devices (TED) - By-catch Reduction Devices (BRD). Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipments; remote sensing.

Module 4 Responsible Fisheries and Fisheries Legislation (9 Hrs)

Concept of Responsible Fisheries; Monsoon trawl ban, closed season, mesh size regulations, juvenile fishing, Exclusive Economic Zone (EEZ), Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM). MSY, MEY, Over fishing, Recruitment over fishing,

Aquaranching. Indian fisheries Act.1976. Coast Guard Act.1978, Maritime zones of India Act.1981

Course code – AQ2CRT06

Biological Tools and Techniques and Research Methodology

Total hours - 36

Credits – 2

Module 1. Microscopy (10Hrs)

Simple Microscope; Compound Microscope; Phase-Contrast Microscope; Transmission Electron Microscope; Scanning Electron Microscope; Fluorescent Microscope; Microphotography; Micrometry.

Module 2. Chromatography (5Hrs)

Chromatographic techniques- Paper Chromatography, Thin layer chromatography, Ion exchange chromatography, gel filtration chromatography, gas chromatography, HPLC.

Module 3. Electrophoresis(6 hrs.)

Principle of electrophoresis, types gel electrophoresis, SDS-PAGE. Centrifugation - Types of centrifugation – differential and density gradient.

Module 4. Histology (5Hrs.)

Histochemical preparation, Fixation and fixatives, Temporary and Whole mount, Specimen preparation for TEM and SEM.

Module 5 .Research Methodology (10 Hrs)

Research Methodology, Scientific method, Research Projects- Steps and process. Types. Research Communication, Research report writing (Structure of a scientific paper), Presentation techniques, Project proposal writing, Assignment, seminar, debate, workshop, colloquium, Conference - Brief description and major differences.

PRACTICAL**Course code** AQ2CRP02**Practical – Freshwater Aquaculture, Fishing Technology and Biological Techniques**

Credits – 2

1. Identification of cultivable freshwater species (12specimens)
2. Modeling of freshwater pond construction
3. Microscopic identification of phytoplanktons (5nos) and zooplanktons (5Nos) from pond water
5. DNA isolation by Electrophoresis
6. Aquaponics system installation and maintenance (Demonstration)
7. Identification of traditional & modern fishing gears – Using FAO catalogue
8. Fishing accessories (floats, ropes, sinkers, swivels, shackles, fishing rods)
8. Identification of synthetic and natural fibres
9. Different types of hooks and baits
10. Knots and splicing
11. **Construction of webbing**
12. **Report on Traditional fish farming and fishing methods of Kerala (Compulsory)**

SEMESTER – III

No	Course	Course Code	Title	Hr/week	Credits
1	Core VII	AQ3CRT07	Biostatistics and Computer Applications	4	3
2	Core VIII	AQ3CRT08	Inland and Marine Fisheries	5	3
3	Core IX	AQ3CRT09	Aquariculture	4	3
4	Core Practical III	AQ3CRP03	Biostatistics and Computer applications (P)	2	2
5		AQ3CRFW 1	Fresh water hatchery training	2	1
6	Complementary Biochemistry			3	3
7	Complementary Biochemistry Practical			1	1
8	Complementary Zoology			3	3
9	Complementary Zoology Practical			1	1
			Total	25	20

Fresh water hatchery training (Credits-1)

During the third semester the student will have to attend training for a minimum of three days in a fresh water fish or prawn hatchery. A certified report of the training signed by hatchery supervisor and the concerned teacher in charge must also be submitted.

Course code – AQ3CRT07

Biostatistics and computer applications

Total hours - 54

Credits – 4

Module 1: Basic Statistics (7 Hrs)

Origin, growth, meaning, definition and use of statistics. Methods of data collection. Biological data collection. Sampling methods. Biological sampling. Classification and tabulation; Diagrammatic and graphical representation of data.

Module 2: Descriptive Statistics (9Hours)

Measures of Central tendency and dispersion. Skewness and kurtosis. Definition, derivation and application of regression and correlation. Applications of linear regression in fisheries. Length weight relationship in fishes; Methodology for estimation of marine fish landings in India.

Module 3: Probability Theory and Statistical Inference (11Hours)

Permutation and combination. Basics of Probability. Theory of random variables. Distribution-normal, binomial and poisson. Testing of hypothesis. Chi-square test, t-test, f-test, Z- test. Analysis of Variance (Basics).

Module 4: Computer - History & Introduction (12Hours)

History of computing; Computer organization - Input-Output devices; Binary system; Operating Systems; Types of Programming Languages (Machine Languages, Assembly Languages, High Level Languages). Data Organization, Drives, Files, Directories. Types of Memory (Primary And Secondary) RAM, ROM, PROM, EPROM. Secondary Storage Devices (FD, CD, HD, Pen drive) I/O Devices (Scanners, Plotters, LCD, Plasma Display) Numbering Systems and Introduction to Binary; Microprocessors.

Module 5: Office Applications (8hours)

Office application software; Word Processors; Spreadsheet; Presentation; Data Base Management; SQL.

Module 6: Web Development and programming (7hours)

Introduction to the World Wide Web; Basics of web development using HTML; Creation of email accounts; Application of Search Engines.

Inland and Marine Fisheries

Course code - AQ3CRT08

Total hours - 54

Credits – 3

Module 1: Riverine and Coldwater Fisheries

(9 Hrs.)

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

Module 2: Reservoir and Estuarine Fisheries

(9 Hrs.)

Reservoir fisheries- Major reservoirs in India- capture fisheries, fishing methods, recent statistics of catches, problems encountered in fisheries development.

Estuarine fisheries- definition and classification of estuaries- capture fisheries- resident and migrant species, fishing methods, recent statistics of catches, problems encountered in fisheries development of major estuaries

Module 3: Marine Fisheries- Pelagic Resources (9 Hrs.)

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

Module 4: Marine Fisheries- Demersal Resources (9 Hrs.)

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

Module 5: Marine Fisheries - Deep Sea Resources (9 Hrs.)

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

Module 6: Fishery Assessment and Regulations (9 Hrs.)

Stratified random sampling for estimation of fish landing. Over fishing – Economic and biological. Conservation and regulation of fishing pressure - closed season, sanctuaries. Important fishing regulations KMFRA, Deep Sea Fishing Policy.

Aquariculture

Course code – AQ3CRT09

Total Hours-54

Credits – 3

Module 1: Aquarium design and Construction (9 Hrs)

Introduction to aquarium. World aquarium trade and present status. Design and construction of home and public aquaria (freshwater and marine), oceanarium. Aquarium accessories - Aerators, filters (different types) and lighting. Water quality requirements.

Module 2: Aquarium Management (9Hrs)

Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes, Quarantine measures. Aquarium maintenance and water quality management. Control of snail and algal growth. Handling, care, packing and transportation of fishes - Use of anesthetics. Temperature acclimation.

Module 3: Freshwater Ornamental Fishes (9 Hrs)

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

Module 4: Commercial Production

(9 Hrs)

Requirements and design for the commercial production units of ornamental fishes. Commercial production of goldfish, live bearers, gouramies, barbs and tetras, angel fish. Natural ponds for the mass production of ornamental fishes. Mass production of aquarium plants.

Module 5: Marine Ornamental Fishes

(9 Hrs)

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

Module 6: Nutrition and Disease

(9 Hrs)

Nutritional requirements of aquarium fishes. Different kinds of feeds. Culture of fish food organisms, Preparation of dry feeds, Feeding methods. Use of pigments for colour enhancement. Larval feeds and feeding. Provision of nutrients and optimum environmental conditions for their growth. Common parasites, Bacterial, viral, fungal diseases of ornamental fishes and their control and prophylaxis.

Course code- AQ3CRP03

Practical – Aquariculture, Biostatistics and Computer Applications

Credits – 2

1. Fresh water Ornamental fishes (6Exotic and 6indigenous fishes)
2. Aquarium accessories (Aerators/filters/dehors/feeding equipments/heaters/pumps/lights)
3. Aquarium plants (6species)
4. Aquarium setting (Freshwater)
5. Input output devices
6. Formatting a document using word, use of mail merge
7. Use of internet to collect fisheries data - FAO, NACA, ICLARM.
8. Graphical representation and tabulation
9. Calculation of mean, median and mode.
10. Standard deviation, Mean deviation and Quartile deviation
11. Inferential statistical analysis t- test, Chi –square, F- test, one way ANOVA, Data analysis using computer
12. Correlation and regression analysis
13. Length weight relationship studies in fishes
- 14. Report on Freshwater Hatchery Training (Compulsory)**

SEMESTER – IV

No	Course	Course Code	Title	Hr/week	Credits
1	Core X	AQ4CRT09	Brackish water aquaculture and mariculture	4	3
2	Core XI	AQ4CRT10	Aquaculture Nutrition	5	3
3	Core XII	AQ4CRT11	Fish Genetics and Biotechnology	4	3
4	Core Practical IV	AQ4CRP04	Fish Nutrition, Genetics and Biotechnology	2	2
5		AQ4CRFW2	Breeding aquarium fish*	2	1
6	Complementary Biochemistry			3	3
7	Complementary Biochemistry Practical			1	1
8	Complementary Zoology			3	3
9	Complementary Zoology Practical			1	1
			Total	25	20

***Breeding any one species of aquarium fish (Credit-1)**

Breeding and larval rearing of any one of the ornamental fish may be done in group of six under the supervision of a faculty of the Department or in any hatchery and the report may be submitted

Course code – AQ4CRT10

Brackishwater Aquaculture and Mariculture

Total Hours-54

Credits – 3

Module 1: Introduction

(6 Hrs)

History, development and present status of brackishwater farming in India. Brackishwater as a medium for aquaculture, ecological factors – abiotic and biotic factors. Selection of site, general planning and design of brackish water farms.

Module 2: Brackishwater Finfish Culture

(6 Hrs)

Cultivable species in brackish water systems. Culture practices – monoculture and polyculture of *Chanos chanos*, *Mugil cephalus*, *Lates calcarifer*, *Etroplus suratensis*, *Oreochromis mossambicus*. Nursery, rearing and grow out in ponds, cages and pens.

Module 3: Crustacean Culture

(6 Hrs)

Species of shrimps cultured in brackishwater – *Penaeus mondon*, *Penaeus indicus*, *Penaeus vannamei*. Extensive, semi-intensive and intensive shrimp farming practices. Species of crabs cultured and culture techniques, prospects in India. Species of lobsters, culture, problems and prospects in India; lobster fattening.

Module 4: Mariculture

(6 Hrs)

Open sea farming – scope and species cultured. Selection of site for sea farming. Different designs of open sea farming structures – construction of cages – bioengineering problems and solutions.

Module 5: Molluscs, Echinoderms and Seaweed Culture (6 Hrs)

Molluscan culture – species of edible oysters, mussels and clams cultured. Important species of pearl oysters and methods of artificial pearl production, mabe-pearl production. Importance of Echinoderms and species cultured. Culture of seaweeds, common cultivable species, culture techniques and harvesting. Important seaweed products.

Module 6: Environmental Impacts (6 Hrs)

Environmental impact of brackish water and coastal aquaculture - Salinity intrusion, effluent discharge, eutrophication, chemical residues including antibiotics and hormones, destruction of natural habitat including paddy field and mangroves. Social issues and conflicts with other users on resources.

AQUACULTURE NUTRITION

Course code - AQ4CRT11

TOTAL HOURS 54

CREDITS 3

Module 1. Nutrient requirement of fish(9 Hours)

Principles of fish nutrition. Role of nutrients: Proteins and amino acids, fatty acids and lipids, carbohydrates, vitamins and minerals. Non-protein nitrogen sources. Role of natural food in fish nutrition. Feed additives - Pigments, immunostimulants, Chemo-attractants, Feed stimulants, Growth promoters, Preservatives; anti-nutritional factors.

Module 2. Feed ingredients and quality (9 Hours)

Criteria for the selection of ingredients for feed preparation. Different feed ingredients- animal, plant, microbial in origin, Fish meal, SCP, silages, fermented products. Storage, quality standards, proximate composition and chemical evaluation. Digestibility studies and methods.

Module 3. Feed and feed manufacturing(12 Hours)

Different forms of feed-fodders, mash pellets, floating and sinking feeds. Types of feed: Dry (pellets, flakes, powdered, micro-encapsulated, microbound and micro-coated diets, Particle assisted rotationally agglomerated microparticulate diet (PARA); Marumerized extruded microparticulate diet (MEM); nano diets, non-dry. Feed formulation methods - Pearson's method, quadratic equation, linear programming; limitations. Feed manufacturing equipments and processes: Pulverizer, grinder, mixer, pelletizer, crumbler, drier, Extruder/ Expander, Vacuum coater, fat sprayer. Different size and grades of fish / shrimp feeds – starter, grower and finisher feeds. Storage and transportation of feeds. Quality problems- toxins, pests, rancidity.

Module 4. Feed management (9 Hours)

Practical feeding in grow-out of fishes and shrimps. Feeding strategies - Feed ration, feed quantity estimation, feeding frequency and feeding methods (Check trays, demand feeders, automatic feeders, feed dispensers). Farm made feeds, factory made shrimp and fish feeds in India. Feed storage: Hydro-stability of feed and their storage; Prevention of spoilage from rancidity, fungus and associated toxins; Fish disease vectors in feed and quality control; Feed value in relation to processing; Use of natural and synthetic carotenoids: Record keeping

Module 5. Feed quality(6 Hours)

Feed energetics, feed conversion ratio, protein efficiency ratio, feed conversion efficiency, net protein utilization, specific growth rate, average weight gain, gross growth coefficient, average daily gain, survival rate. EAAI, chemical score, biological value. Physical properties of feed: Leaching, water stability, bulk density, water absorption, expansion ratio, sinking velocity. Aqua feed industries in India. Factors affecting digestibility. Quality standards.

Module 6. Larval nutrition (9 Hours)

Nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults, quality requirements of larval feeds (particle size and digestibility), natural food and its importance in aquaculture, nutritional quality of commonly used fish feed organisms, bioenrichment, biofilm / periphyton and its uses. Bacterioplankton, phytoplankton and zooplankton and their role in larval nutrition. Culture of single cell proteins and their nutritional quality, culture of important microalgae, rotifers, artemia, cladocerans, copepods, oligochaetes, nematodes and insect larvae

Fish Genetics and Biotechnology

Course code- AQ4CRT12

Total Hours-54

Credits-3

Module 1: Basic Genetics

(9 Hrs)

Principles of genetics, Mendel's law of inheritance - allelic and non-allelic interactions of genes – complete, incomplete, pleiotropism, epistasis, supplementary and complementary genes. Biochemical genetics, quantitative genetics, population genetics.

Module 2: Selection and Hybridisation

(9 Hrs)

Selection - mass selection, genotypic selection, family and sib selection, progeny testing and combined selection. Principles of breeding - methods and selection, selective hybridisation, intra-specific and inter-specific hybridisation – GIFT tilapia. Hybrid vigor, inbreeding and cross breeding.

Module 3: Sex determination.

(9 Hrs)

Practical application of genetics in aquaculture. Genetics of sex determination in fish. Gonochorism, Hermaphroditism, Protandry, Protogyni, Environmental Influence of Sex Determination.

Module 4: Aquaculture Biotechnology

(9 Hrs)

Recombinant DNA technology, Use of PCR for the detection of white spot syndrome in shrimp. Aquaculture biotechnology- Biotechnological tools for aquaculture, gene manipulation in fish, transgenic fish production.

Module 5: Chromosome manipulation in fish and shell fishes (9 Hrs)

Polyploidy, gynogenesis and androgenesis. Monosex production, super male and super female fish production techniques, sex reversal - methods. Cryopreservation of gametes.

Module 6: Marine Biotechnology

(9 Hrs)

Synthetic hormones for induced breeding. Application of tissue culture in seaweed and pearl production. Marine toxins. Industrial chemicals and pharmaceuticals from marine sources. Use of probiotics and antibiotics in aquaculture operations.

Fish nutrition, Genetics and Biotechnology (2-CREDITS)

Course code- AQ4CRP04

Experiments:

1. Identification of feed ingredients
2. Processing of feed ingredients
3. Feed additives
4. Feed formulation and preparation
5. Determination of sinking rate and water stability of feeds.
6. Determination of proximate composition of feed
7. Estimation of physical properties of feed: Bulk density, water absorption, expansion ratio, sinking velocity.
8. Isolation of DNA
9. Milt-Quality assessment
10. Short term storage of milt

SEMESTER - V

No	Course	Course Code	Title	Hr/week	Credits
1	Core 13	AQ5CRT13	Fishery Microbiology	6	4
2	Core 14	AQ5CRT14	Fish Pathology	6	4
3	Core practical 5	AQ5CRP05	Fishery microbiology and pathology	3	3
4	Core practical 6	AQ5CRP06	Aquafarm management	3	3
5	OJT	AQ5CROJ	On the job training	4	5
6	Generic Elective	AQ5GET1 AQ5GET2 AQ5GET3	1. Hatchery Technology 2. Fish Preservation Techniques 3. Value Added Fishery Products	3	3
			Total	25	22

On the job training (4 credits)

In the fifth semester students will have to undergo On the job training for 21days attached to a processing plant/recognized Institute. They have to submit the OJT record signed by the supervisor along with the attendance certificate. (OJT record – 3 Credits + Viva- 1 Credit)

Fishery Microbiology

Course code – AQ5CRT13

Total Hours-72

Credits – 4

Module 1: Introduction (12 Hrs.)

History and development of microbiology – Contributions of Louis Pasteur, Koch and Winogradsky –Diversity of microbial community – General characteristics of bacteria, fungi, viruses, algae and protozoans. .

Module 2: Structure of microbes (12 Hrs.)

Structure of prokaryotic cell, Structure and function of bacterial cell wall, plasma membrane, capsule, flagella and endospore. Structure of fungi and yeast cell. Structure of virus. Classification of viruses. Life cycle bacteriophages - lytic and lysogenic cycle.

Module 3: Isolation and culture of microbes (12 Hrs.)

Prokaryotic growth – characteristic features of bacterial growth curve – Effect of environmental factors on growth. Nutrition and growth of bacteria – different types of media for isolation of bacteria and fungi. Isolation and cultivation of bacteria and fungi from water and sediment. Different culture techniques.

Module 4: Aquatic Microbiology (12 Hrs.)

Microflora of aquatic environment. Autotrophic and heterotrophic microorganisms in aquatic environment. Nutrient regeneration, role of microbes

in biogeochemical cycles – Carbon, Nitrogen, Phosphorus and Sulphur cycles. Autochthonous and allochthonous microorganisms in aquatic environment.

Module 5: Bacteria in culture pond

(12 Hrs.)

Health significant bacteria in culture ponds. Culture characteristics and epidemiology of *E. coli*, pathogenic *Vibrios*, *Salmonella*, *Aeromonas hydrophila*, and *Pseudomonas*.

Module 6: Fish Microbiology

(12 Hrs.)

Perishability of seafood – Microbial spoilage of fish and shell fish. Spoilage microflora. Intrinsic and extrinsic factors affecting spoilage. Microflora associated with body parts. Food borne pathogens. Sources of contamination.

Fish Pathology

Course code – AQ5CRT14

Total Hours-72

Credits – 4

Module 1. Pathology and Parasitology (12hours)

Introduction to fish diseases: Basics of fish and shellfish health management: Host-pathogen-environment relationship, Management of culture systems. Disease and environment. Stress as a factor in diseases. Parasitism- host parasite relationship.

Module 2. Fungal and Viral diseases (12hours)

Fungal diseases- Saprolegniasis, branchiomycosis, ichthiophonous disease, Laginedium disease, Fusarium disease. Viral diseases in finfishes – Infectious Haematopoietic Necrosis, Infectious

Pancreatic Necrosis, Viral Haemorrhagic Septicaemia, Spring Viraemia of carps, Channel catfish disease, lymphocystis disease. Viral pathogens in shell fishes- Baculovirus penaeii, White spot syndrome virus, Monodon baculovirus, baculovirus midgut necrosis, Hepatopancreatic virus, Yellow head baculovirus, Systemic Ectodermal Mesodermal baculovirus

Module 3 Bacterial, protozoan and metazoan diseases(12hours)

Common bacterial diseases of finfishes - Enteric red mouth disease, Epizootic ulcerative syndrome, Bacterial cold water disease, furunculosis, vibriosis, dropsy, gill disease, Haemophilosis, Edwardsiellosis. Bacterial diseases of shellfish - Vibriosis, hepatopancreatitis, rickettsia diseases, mycobacteriosis. Bacterial luminescent disease and Bacterial filamentous disease. Diagnosis and treatment protocols. Protozoan disease- Ichthiophthiriasis, costiasis, whirling disease, trypanosomiasis. Metazoan diseases- disease caused by annelids, helminthes, crustaceans and molluscs.

Module 4 Nutritional and Environmental diseases. (12hours)

Nutritional pathology- Lipid liver degeneration. Vitamin and mineral deficiency diseases. Aflatoxin and dinoflagellates. Antibiotics and chemotherapeutics. Nutritional cataract, fish anaemia, enlarged liver, scoliosis, lordosis, broken back disease, fatty liver syndrome, pale liver syndrome. Genetically and environmentally induced diseases. Environmental diseases- Gas bubble disease, yolk coagulation disease, blue sac diseases in eggs, alkalinosi, acidosis. Hereditary diseases

Module 5. Immunology (12hours)

Introduction to fish immunology and terminologies; Defense system and mechanism in fish and shellfish: innate and acquired immunity, inflammation response to diseases. Antibody and cell mediated immunity in fish and shellfish. Application and development of vaccines and antibiotics,

Diagnostic tools, immune detection- DNA/RNA techniques. General preventive methods and prophylaxis.

Module 6. Fish health management (12hours)

Methods for disease control and management, chemotherapeutic agents, host management, prophylaxis- vaccines, adjuvants, immunostimulants and probiotics. Use and abuse of antibiotics and chemicals in health management. Fish health and quarantine systems. Seed certification, SPF and SPR. Good pond management practices. Methods of pathological examinations of fish and infectious diseases. Evaluation criteria of healthy seeds. Good feed management for healthy organisms.

Generic Elective

HATCHERY TECHNOLOGY

Course code – AQ5GET1

TOTAL HOURS-72

CREDITS-4

Module 1: Carp Hatchery

15 hrs

Hatchery management- Seed production of carps. Hypophysation of Indian major carps and exotic carps, history of hypophysation. Methods of pituitary gland collection and preservation, broodstock management, sexing, dosage , mechanism of ovulation and other ovulating agents spawning and hatching.

Production of common carp seeds, breeding techniques, Sundanese, Tjimindi, Rantjapaku and Central Sumatra methods. Methods followed in China and India. Transport of fish seed and brood fishes, use of anesthetics. Bundh breeding, types of bundh breeding techniques and problems of bundh breeding.

Module 2: Seed production of other fishes

5 hrs

Seed production and hatchery operations of *Onchorhynchus mykiss*, *Mugil cephalus*, *Oreochromis mossambicus*, and *Lates calcarifer*.

Module 3: Seed production of crustaceans

15 hrs

Hatchery operations of *Penaeus indicus*- Design of shrimp hatchery, various components, equipments, and infrastructure facilities. Transportation of brooders, induced breeding techniques and larval rearing operations.

Hatchery operations of mud crabs-selection of site, various components, transportation of brooders, induced breeding techniques (Eyestalk ablation) and larval rearing operations.

Hatchery operations of *Macrobrachium rosenbergii* –Transportation of brooders, wild seed collection and larval rearing operations. Clear water and green water systems

Module 4: Seed production of Molluscs

15 hrs

Hatchery operations of pearl oysters and mussels: site selection, infrastructure facilities and equipments, induced breeding techniques, seed collection and larval rearing operations, remote setting.

Module 5: Hatchery management

4 hrs

Selection criteria for brood stock and brood stock management; water quality monitoring and management; quality assessment of seeds; quarantine and disease management in hatcheries.

Fish Preservation Techniques

Course code AQ5GET2

Total Hours-72

Credits – 4

Module 1: Fish handling

(12 Hrs.)

Commercially important seafood species in India. Handling of fish - on board, landing center and processing centre. Design and layout of pre-processing and processing centers.

Module 2: Chilling and Freezing

(12 Hrs.)

Icing of fish, different types of ice, quality of ice. Fundamental principles involved in chilling and freezing of fish and fishery products. Various freezing methods. RSW/CSW systems. Changes during freezing and frozen storage.

Module 3: Drying, Smoking, Canning and Freeze-Drying

(12 Hrs.)

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

Module 4: Quality Control in Sea Food Processing

(12 Hrs.)

Concept of quality in fish and fishery products. Organoleptic analysis of fish and fishery products. Microbiological analysis of fish and fishery products. TPC and MPN of coliforms in sea food. *Salmonella*, *Vibrio*, *Staphylococcus* and *E. coli* in sea food. Quality standards for sea food. Concept of HACCP.

Module 5:Fishery By-products

(12 Hrs.)

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

Module 6:Packing, Cold Storage and Export of Fishery Products (12 Hrs.)

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

Value Added Fishery Products

Course code –AQ5GET3

Total Hours-72

Credits – 4

Module 1: Value Addition in Sea Foods (12 Hrs)

Different types of value added products from fish and shell fish – status of value addition in Indian seafood sector. Advantages of value addition. Significance of value addition in the seafood industry.

Module 2: Fish Mince Based Products (12 Hrs)

Fish mince and Surimi. Production of fish mince – merits and demerits. Analog and fabricated products. Quality assessment of surimi. Equipment, raw material for surimi, Role of cryoprotectants in surimi production.

Module 3: Coated Fishery Products (12 Hrs)

Preparation of coated fishery products – Different types of batter and breading and its applications – Packaging and storing of coated products – Quality evaluation.

Module 4: Other Value Added Products (12 Hrs)

Preparation of products- fish / prawn pickle, fish wafers, prawn chutney powder, fish soup powder, fish protein hydrolysate, fish stacks, extruded fish products, fillets, fish curry, fish cutlet, mussel products, marinated products

Module 5: By-Products

(12 Hrs)

Production of chitin, chitosan and glucosamine hydrochloride from shrimp shell waste. Preparation of fish silage. Uses of silage. Isinglass, shark fin rays, gelatin from fish waste, ambergris, beche-de-mer, squalene, fish meal and fish body/liver oil.

Module 6: Spoilage and quality

(12 Hrs)

Spoilage in thermal processed products – Quality evaluation of thermal processed products – Curing and drying of fish – Spoilage in dry fish products.

Fishery Microbiology and Pathology

Course code –AQ5CRP05

Credits- 2

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 coliforms (MPN technique)
7. Identification of various finfish / shellfish disease
8. Parasite in fishes, protozoan, helminths, crustaceans
9. Prophylaxis for the prevention of outbreak of fish disease
10. Larval diseases

PRACTICALS**Aqua Farm Management (2-CREDITS)**

Course code- AQ5CRP06

Identification of cultivable aquatic organisms (Fin fish-6, Prawn-3, Crab – 2, Lobster- 1, Molluscs -3)

1. Identification of common weed and predatory fishes (3each)
2. Collection and identification of phytoplanktons and zooplanktons in an aquaculture pond (any 3 each)
3. Identification of different larval stages of shrimp
4. Identification and working of various equipments in farm and hatchery
5. Eradication of aquatic weeds, insects, weeds and predatory fishes from aquaculture pond.
6. Identification of different live feed organisms (6Nos)
7. Enumeration of micro algae using haemocytometer
8. Decapsulation and hatching of artemia cyst
9. Calculation of feed requirement
10. Preparation of artificial feed with local ingredients and feed cost estimation
11. Earthwork calculation (Field study)
12. Economic analysis of carp farming & shrimp farming

BSc. AQUACULTURE

SEMESTER – VI

No	Course	Course Code	Title	Hr/week	Credits
1	Core 15	AQ6CRT15	Aquaculture Management	6	4
2	Core 16	AQ6CRT16	Aquaculture Engineering	6	4
3	Core 17	AQ6CRT17	Fisheries Economics and extension	6	4
4	Core practical - 7	AQ6CRP07	Fish processing technology and quality control	2	2
5	Core Practical - 8	AQ6CRP08	Water and Soil Quality Parameters	2	2
6	Project work*	AQ6CRPR			3
7	Study tour**	AQ6CRST			1
8	Core Elective	AQ6CB1 AQ6CB2	Choice Based Paper – II 1.Fishery by products 2.Aquaculture and Management of Ecosystems	4	4
			Total	25	24

*Project work must be done under a faculty of the Department. The project supervisors may be allocated during the end of second semester. Project may also be done at any research/educational institutions under the combined guidance of a regular staff of the research Institution and a faculty from the Department. Completed project report may be submitted at the end of Semester VI in standard format.

** Study tour extending not less than six days may be conducted during the sixth semester. The tour should include National Fishery research and educational Institutions, harbours, visit to shrimp/fish hatchery, aquariums, farms etc., Few lecture classes may also be arranged during the tour. Visit to a natural coral/mangrove/estuarine/riverine ecosystem and its fauna study must also be included. A tour report may be submitted at the end of the Semester VI, certified by the Head of the Department and the tour coordinator in bound form.

Semester VI

Course code – AQ6CRT15

AQUACULTURE MANAGEMENT

Total Hours-72

Credits – 4

Module 1: Introduction to Aquaculture Management (12 hrs.)

Principles of culture systems and management, Scope of Aquaculture Management. Organisational systems, Operational systems and Degree of Intensification. Management skills, Motivation, Productivity.

Module 2: Water and health management (12 hrs.)

Water Quality Management, Aeration, Water Injection, Effluent- environmental impacts and treatment-ETP. Management of water supply

Module3: Environmental Ethics (12 hrs.)

Management of scarce Natural Resources to commodity production for human consumption, Moral standing, animal rights.

Module 4: Production Economics (12 hrs.)

Microeconomic principles, Fixed and variable costs, Marginal analysis, cost concept, Taxes, Interest, Maintenance, Insurance, Depreciation, Total ownership costs.

Module 5: Records for managerial analyses, Production system limits (12 hrs.)

Management Principles, Definition, Scope, Principles, Henry Fayol Scientific Management - Application in Aquaculture, Capacity estimates, Production capacity assessment (PCA), Procedure for PCA.

Module 6: Decision making tools (12 hrs.)

Partial Budgeting, The Delphi Technique, Benefit-cost analysis, Present value analysis, Sensitivity analysis, decision trees.

AQUACULTURE ENGINEERING

Course code – AQ6CRT16

Total Hours-72

Credits – 4

Module 1: Introduction (12 hrs.)

Technical components of farm designing, recent trends in aquaculture engineering.

Module 2: Aquaculture facilities (12 hrs.)

Planning process, site selection and evaluation, design, components and construction of tanks, ponds, cages and hatcheries.

Module 3: Water intake and outlet, treatment (12 hrs.)

Pipe line, water flow and head loss, pumps-different types. Equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection.

Module 4: Aeration, oxygenation and Recirculation (12 hrs.)

Design and fabrication of aerators, compressors, blowers, paddle wheel aerators, oxygen injection system. Recirculation and water use systems- components and design.

Module 5: Feeding system (12 hrs.)

Different types of feeding equipments, feed control systems, dynamic feeding systems.

Module 6: Instrumentation and monitoring (12 hrs.)

Instruments for measuring water quality. Salinometer, pH meter, Secchi Disc, use of test kits.

Fisheries Economics and Extension

Course code - AQ6CRT17

Total Hours-72

Credits – 4

Module 1: Introduction (12 Hrs)

Economics- definition, meaning and scope of economics with reference to fisheries. Basic concepts of economics- goods, services, wants, utility. Demand

and supply, value price, individual demand and market demand, elasticity of demand, law of diminishing marginal utility. Theory of production- the production function, the laws of returns, returns to scale, production function in a fishery. Average, marginal and total revenues. Pricing-various factors influencing the price of a product.

Module 2: Basics of Business

(12 Hrs)

Nature and scope of business, meaning, definition, characteristics and functions of business. Requisites of a successful business, essential qualities of a good business man, different economic systems in operation- capitalism, communist economy and mixed economy. Classification of companies- sole, proprietorship, partnership, co-operative society, charter companies, public corporations and registered companies.

Module 3: Marketing and Economic Analysis

(12 Hrs)

Marketing – Introduction, basic marketing functions, consumer behavior and demand concepts, different types of market, identifying and selecting markets, regulation of markets, advertising and sales promotion, organizing market surveys and test marketing of a new product. Fish marketing – prices and price determination of fishes. Marketing institutions; Primary institutions- producer fishermen, fishermen cooperatives and fisheries corporations. Secondary institutions – merchant middlemen, agent middlemen and speculative middlemen.

Module 4: Aquaculture and Fisheries Economics

(12 Hrs)

Aquaculture economics – Application of economic principles to culture operations. Various inputs. Production function - its assumptions in aquaculture analysis. Least cost combination of inputs, laws of variable proportions. Cost and earnings of aquaculture systems – carp culture, different shrimp farming systems and hatcheries. Cost and earnings of mechanized and non-mechanized fishing units and freezing plants. Socio- economic conditions of fishermen in India and Kerala. Contributions of fisheries to the national economy. Budget allocation for fisheries in Union and State budget

Module 5: Fisheries Co-operatives

(12 Hrs)

Co operation- basic principles, co operative legislation and its administrative structure. Fishermen co operatives, its functions, village societies, producing and marketing apex societies. Financing and special problems of fishermen co operatives and remedial measures. Role of National Co operative Development Corporation, Matsyafed and NABARD in uplifting the socio economic conditions of fishermen.

Module 6: Fisheries Extension

(12 Hrs)

Extension education – Meaning, importance and scope in fisheries. Various methods of extension – individual, group and mass methods, farm and home visits, seminars, discussions, exhibition and personal contacts. Extension and rural development – rural sociology, social structure and stratification, social institutions and community organizations.

Choice based Paper II

FISHERY BY - PRODUCTS

Course code- AQ6CBT1

Total Hours-72

Credits – 4

Module 1: Value Addition in Seafood (12 Hrs)

Different types of value added products from fish and shell fish – status of value addition in Indian seafood sector. Advantages of value addition. Significance of value addition in seafood industry.

Module 2: Fish Mince Based Products (12 Hrs)

Fish mince and Surimi. Production of fish mince – merits and demerits. Analog and fabricated products. Quality assessment of surimi. Equipment, raw material for surimi, Role of cryoprotectants in surimi production.

Module 3: Coated Fishery Products (12 Hrs)

Preparation of coated fishery products – Different types of batter and breading and its applications – Packaging and storing of coated products – Quality evaluation.

Module 4: Other Value Added Products (12Hrs)

Preparation of products viz. fish / prawn pickle, fish wafers, prawn chutney powder, fish soup powder, fish protein hydrolysate, fish stacks, fillets, fish curry, mussel products, marinated products

Module 5: Fishery By-Products (12 Hrs.)

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, fish ensilage and seaweed products like agar, alginic acid and carrageenan.

Module 6: Spoilage and quality (12 Hrs)

Spoilage in thermal processed products – Quality evaluation of thermal processed products – Curing and drying of fish – Spoilage in dry fish products.

AQUACULTURE AND MANAGEMENT OF ECOSYSTEM

Course code - AQ6CBT2

Total Hours-72

Credits – 4

Module 1: Aquaculture and ecosystem relationship (12 Hrs)

Ecosystems and productivity, biotic interaction within ecosystems and ecological homeostasis.

Module 2: Climate (12 Hrs)

Weather elements of concern in aquaculture, Green house gases, global warming and their impact.

Module 3: Impact of environment on aquaculture (12 Hrs)

Raw water source, physical and chemical characteristics, contaminants and pollutants (algae, pathogens, heavy metals, pesticides) and their effect on productivity.

Module 4: Impact of aquaculture on environment (12 Hrs)

Waste water discharge, its quality and quantity; impacts of effluents on ecosystems, chemical degradation of soil and water.

Module 5: Environment monitoring (12 Hrs)

Problems and preventive measures of antibiotic and drug residues, salination of soil and water, Eutrophication, Environment impact assessment and environmental audit, Biosensors in aquatic environment, toxicity assessment, Ecolabelling and traceability.

Module 6: Environment management (12 Hrs)

Introduction of exotics and escape of farmed fish, Pathogens in aquatic environment, Safety of aquaculture products, Role of microbes in aquatic environment; assessment of probiotic impact in aquaculture. Bioremediation.

Practical

Fish Processing Technology and Quality Control

Course code – AQ6CRP07 (CREDITS 2)

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

Course code – AQ6CRP08

Water and Soil Quality Parameters

Total hours - 36

Credits – 2

Experiments:

1. Determination of salinity (Mohrs method and verification with salinometer)
2. Determination of water pH(using P^H meter)
3. Determination of alkalinity
4. Determination of hardness of water
5. Determination of dissolved oxygen
6. Estimation of primary productivity
7. Determination of organic carbon in pond soil
8. Determination of nitrite / nitrate - **demonstration**
9. Determination of phosphate in pond water - **demonstration**
10. Determination of soil pH
11. Calculation of lime requirement
12. Grain size analysis of soil
13. Determination of Secchi disc transparency of water