



CURRICULUM AND SYLLABI

CHOICE BASED CREDIT SYSTEM

(CBCS-PG)

M. Sc AQUACULTURE AND FISH PROCESSING PROGRAMME

INTRODUCED FROM 2016 ADMISSION ONWARDS

BOARD OF STUDIES IN AQUACULTURE

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA, KOCHI, KERALA

SACRED HEART COLLEGE (AUTONOMOUS) THEVARA, KOCHI -13.

1. SCOPE

1.1. These regulations provided herein shall apply to all post-graduate programmes, conducted by Sacred Heart College (S.H.college), Thevara with effect from the academic year 2016-2017 admission onwards.

2. DEFINITIONS

2.1 **'Academic Committee'** means the Committee constituted by the principal under this regulation to monitor the running of the Post-Graduate programmes under the Choice Based Credit System (CBCS-PG).

2.2 **'Programme'** means the entire course of study and examinations.

2.3 **'Duration of Programme'** means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be of 4 semesters.

2.4 **'Semester'** means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days, each with 5 contact hours of one hour duration

2.5 **'Course'** means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork / study tour / seminar / project / practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

2.6 **'Credit' (Cr)** of a course is the numerical value assigned to a paper according to the relative importance of the content of the syllabus of the programme.

2.7 **'Programme Credit'** means the total credit of the PG Programmes, i.e.; **80 credits**.

2.8 **Programme Core course'** Programme Core course means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

2.9 **'Programme Elective course'** Programme Elective course means a course, which can be chosen from a list of electives and a minimum number of courses is required to complete the programme.

2.10 **'Programme Project'** Programme Project means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department / any appropriate Institute in order to submit a dissertation on the project work as specified.

- 2.11 **'Plagiarism'** Plagiarism is the unreferenced use of other authors' material in dissertations and is a serious academic offence.
- 2.12 **'Tutorial'** Tutorial means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.
- 2.13 **'Seminar'** seminar means a lecture expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.
- 2.14 **'Evaluation'** means every course shall be evaluated by 25% internal assessment and 75% external assessment.
- 2.15 **'Repeat course'** is a course that is repeated by a student for having failed in that course in an earlier registration.
- 2.16 **'Audit Course'** is a course for which no credits are awarded.
- 2.17 **'Department'** means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.
- 2.18 **'Parent Department'** means the Department which offers a particular Post graduate programme.
- 2.19 **'Department Council'** means the body of all teachers of a Department in a College.
- 2.20 **'Faculty Advisor'** is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.
- 2.21 **'College Co-coordinator'** means a teacher from the college nominated by the College Council to look into the matters relating to CBCS-PG System
- 2.22 **'Letter Grade'** or simply **'Grade'** in a course is a letter symbol (S, A, B, C, D, etc.) which indicates the broad level of performance of a student in a course.
- 2.23 Each letter grade is assigned a **'Grade point'** (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.
- 2.24 **'Credit point'** (CP) of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course $CP=GP \times Cr$.
- 2.25 **'Extra credits'** are additional credits awarded to a student over and above the minimum credits required for a programme for achievements in co-curricular activities carried out outside the regular class hours as directed by the College/ department.

2.26 **'Semester Grade point average'** (SGPA) is the value obtained by dividing the sum of credit points (CP) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester. The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

2.27 **Cumulative Grade point average'** (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places.

2.28 **'Grace Marks'** means marks awarded to course/s, as per the orders issued by the college from time to time, in recognition of meritorious achievements in NCC/NSS/Sports/Arts and cultural activities.

2.29 **'Words and expressions'** used and not defined in this regulation but defined in the Mahatma Gandhi University Act and Statutes shall have the meaning assigned to them in the Act and Statute.

3. ACADEMIC COMMITTEE

3.1 There shall be an Academic Committee constituted by the principal to manage and monitor the working of (CBCS-PG) 2016.

3.2 The Committee consists of

- (a) The principal
- (b) The vice principal
- (c) Deans of the faculties of science, arts and commerce
- (d) The Controller of Examinations
- (e) IQAC –Co-coordinator
- (f) The superintendent of the college

4. PROGRAMME STRUCTURE

4.1 Students shall be admitted into post graduate programmes under the various faculties.

4.2 The programme shall include two types of courses, Program Core (C) courses and Program Elective (E) Courses. There shall be a Program Project (D) with dissertation to be undertaken by all students. The Programme will also include assignments, seminars, practical (P), viva (V), study tour etc., if they are specified in the Curriculum

4.3 There shall be various groups of four Programme Elective courses for a programme such as Group A, Group B etc. for the choice of students subject to the availability of faculty and infrastructure in the institution and the selected group shall be the subject of specialization of

the programme.

4.4 **Project work**

4.4.1 Project work shall be completed by working outside the regular teaching hours.

4.4.2 Project work shall be carried out under the supervision of a teacher in the concerned department.

4.4.3. A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization/ Institute on the recommendation of the Supervisor.

4.4.4 There should be an internal assessment and external assessment for the project work in the ratio 1:3

4.4.5 The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce.

4.4.6 The mark and credit with grade awarded for the program project should be entered in the grade card issued by the college.

4.5. **Assignments:** Every student shall submit one assignment as an internal component for every course.

4.6 Seminar Lecture: Every PG student may deliver one seminar lecture as an internal component for every course. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

4.7 Every student shall undergo **two class tests** as an internal component for every course.

4.8 The attendance of students for each course shall be another component of internal assessment.

4.9 Comprehensive Viva-voce shall be conducted at the end of the programme which covers questions from all courses in the programme as per the syllabus.

5. ATTENDANCE

5.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of Post Graduate programme may be granted by the College as forwarded on the recommendation by the class teacher/HOD.

5.2 If a student represents the college in University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union / University union

activities, he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of 10 days in a Semester based on the specific recommendations of the Head of the concerned Department and Principal of the College.

5.3 A student who does not satisfy the requirements of attendance shall not be permitted to take the end Semester examinations.

5.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch

6. BOARD OF STUDIES AND COURSES.

6.1 The Board of Studies concerned shall design all the courses offered in the PG programme. The Boards shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposures and training for the students.

6.2 The syllabus of a course shall include the title of the course, contact hours, the number of credits and reference materials.

6.3 Each course shall have an alpha numeric code number which includes abbreviation of the subject in two letters, the semester number, the code of the course and the serial number of the course ('C' for Program Core course, 'E' for Program Elective course, 'O' for Open Elective course, 'P' for Practical and 'D' for Project/ Dissertation and 'V' for Comprehensive Viva voce).

6.4 Every Programme conducted under Choice Based Credit System shall be monitored by Academic committee and the College Council.

7. REGISTRATION.

7.1 A student shall be permitted to register for the programme at the time of admission. The duration of the PG Programme shall be 4 semesters.

7.2 A student who registered for the course shall complete the course within a period of 8 continuous semesters from the date of commencement of the programme.

8. ADMISSION

8.1 The admission to all PG programmes shall be as per the rules and regulations of the college.

8.2 The eligibility criteria for admission shall be as announced by the college from time to time.

8.3 There shall be provision for inter collegiate and inter University transfer within a period of two weeks from the date of commencement of the semester.

8.4 There shall be provision for credit transfer subject to the conditions specified by the Board of Studies concerned.

9. ADMISSION REQUIREMENTS

9.1 Candidates for admission to the first semester of the PG programme through CBCS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of the college as equivalent thereto.

9.2 The candidate must forward the enrolment form to the Controller of Examinations of the college through the Head of the Department.

9.3 The candidate has to register all the courses prescribed for the particular semester. Cancellation of registration is applicable only when the request is made within two weeks from the time of admission.

9.4 Students admitted under this programme are governed by the Regulations in force.

10. **PROMOTION:** A student who registers for the end semester examination shall be promoted to the next semester

11. EXAMINATIONS

11.1 There shall be an external examination at the end of each semester.

11.2 The answers must be written in **English** except for those coming under Faculty of languages.

11.3 Practical examinations shall be conducted by the college at the end of the semesters as per the syllabus.

11.4 Project evaluation and Comprehensive Viva -Voce shall be conducted as per the syllabus. Practical examination, Project evaluation and Comprehensive Viva-Voce shall be conducted by two external examiners.(For professional courses, one examiner can be opted from the same college itself)

11.5 There shall be one end-semester examination of 3 hours duration in each lecture based course (Theory).

11.6 A question paper may contain multiple choice /objective type, short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different marks, but a general pattern may be followed by the Board of Studies.

12 EVALUATION AND GRADING

12.1 Evaluation: The evaluation scheme for each course shall contain two parts; (a) internal evaluation (ISA) and (b) end semester evaluation (ESA). 25 marks shall be given to internal evaluation and 75 marks to external evaluation so that the ratio between internal and external mark is 1:3. Both internal and external evaluation shall be carried out in mark system. Both internal and external marks are to be mathematically rounded to the nearest integer.

12.2 Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars/viva/field survey and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The marks assigned to various components for internal evaluation is as follows.

12.3

Components of Internal Evaluation

All the components of the internal evaluation are mandatory

a) For Theory

	Components	Marks
i.	Assignment	5
ii	Seminar/Quiz/Field survey /Viva etc.	5
iii	Attendance	5
iv	Two Test papers(2x5)	10
	Total	25

b) For Practical

Components	Marks
Attendance	5
Written/Lab test	5
Laboratory Involvement/ Record*	10
Viva	5
Total	25

*Marks awarded for Record should be related to number of experiments recorded

c) For Project

Components	Marks
Topic/Area selected	2
Experimentation/Data collection	5
Punctuality	3
Compilation	5
Content	5
Presentation	5
Total	25

12.4 Evaluation of, Attendance

% of attendance	Mark
Above 90%	5
Between 85 and < 90	4
Between 80 and below 85	3
Between 76 and below 80	2
75	1

Assignment

Components	Marks
Punctuality	1
Content	2
Conclusion	1
Reference/Review	1
Total	5

Seminar

Components	Marks
Content	2
Presentation	2
Reference/Review	1
Total	5

To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal mark.

12.5 The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the controller of examinations

through the Principal and a copy should be kept in the college for at least two years for verification.

12.6 External Evaluation: The external examination in theory courses shall be conducted by the college with question papers set by external experts/ question bank. The evaluation of the answer scripts shall be done by the examiners based on a well-defined scheme of evaluation given by the question paper setters. The external evaluation shall be done immediately after the examination preferably through the centralised valuation.

12.7 The question paper should be strictly on the basis of model question paper set by BOS with due weightage for each module of the course and there shall be a combined meeting of the question paper setters and experts for scrutiny for finalisation of question paper. Each set of question should be accompanied by its scheme of valuation.

12.9 For all courses (theory & practical), Letter grades and grade point 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 (GP)
95 and above	O 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 Average	5
40 to below 45	D Pass	4
Below 40	F Fail	0
	Ab Absent	0

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

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

12.8 A **separate minimum of 40% marks** (D grade) required for a pass for both internal evaluation and external evaluation for every course.

12.11 A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the end semester examination for the same semester, subsequently.

12.12 A student who fails to secure a minimum marks/grade for a pass in a course will be permitted to write the examination along with the next batch.

There will be no improvement examinations

12.13 After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of semester, a student should pass all courses and score a minimum SGPA of 4.0. However, a student is permitted to move to the next semester irrespective of her/his SGPA.

Credit Point (CP) of a course is calculated using the formula

$CP = Cr \times GP$, where Cr = Credit; GP = Grade point

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

$SGPA = TCP/TCr$, where

$TCP = \text{Total Credit Point of that semester} = \sum_1^n CP_i$;

$TCr = \text{Total Credit of that semester} = \sum_1^n Cr_i$

Where n is the number of courses in that semester

Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula

$CGPA = \frac{\sum(TCP \times TCr)}{\sum TCr}$ **GPAs shall be rounded off to two decimal places**

12.14 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. He/She shall also submit a detailed scheme of evaluation along with the question paper.

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

Pattern of questions for external examination for theory paper

Type of Questions	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Section A – Short Answer	12	8	2	16
Section B- Short essay/ Problems	10	7	5	35
Section C- Long essay	4	2	12	24
	26	17		75

Pattern of questions for external examination of practical papers will be decided by Practical exam board chairman as per the guidelines of Board of Studies.

13. GRADE CARD

The colleges under its seal shall issue to the students, a grade card on completion of each semester, which shall contain the following information.

- a) Name of the College
- b) Title of the Postgraduate Programme
- c) Name of the Semester
- d) Name and Register Number of the student
- e) Code, Title, Credits and Max. Marks (Internal, External & Total) of each course (theory & Practical) in the semester.
- f) Internal, External and Total Marks awarded, Grade, Grade point and Credit point in each course in the semester
- g) The total credits, total marks (Max. & Awarded) and total credit points in the semester
- h) Semester Grade Point Average (SGPA) and corresponding Grade.
- i) Cumulative Grade Point Average (CGPA)
- j) The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses (theory & practical) taken during the final semester examination and shall include the final grade/marks scored by the candidate from 1st to 3rd semester, and the overall grade/marks for the total programme.

14. AWARD OF DEGREE

The successful completion of all the courses with 'D' grade (40%) shall be the minimum requirement for the award of the degree

15. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the principal consisting of faculty advisors, HOD, a member from teacher learning evaluation committee (TLE) and college coordinator to monitor the internal evaluations conducted by college. The Course teacher, Faculty Advisor, and the College Coordinator should keep all the records of the internal evaluation, for at least a period of two years, for verification.

16. GRIEVANCE REDRESSAL MECHANISM

In order to address the grievance of students regarding Continuous internal assessment (CIA) 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: At the level of the concerned course teacher

Level 2: At the level of a department committee consisting of the Head of the Department, a coordinator of internal assessment for each programme nominated by the HoD and the course teacher concerned.

Level 3: A committee with the Principal as Chairman, Dean of the concerned Faculty, HOD of concerned department and one member of the Academic council nominated by the principal every year as members.

17. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of three year from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

18. REPEAL

The Regulations now in force in so far as they are applicable to programmes offered by the college and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Choice Based Credit System in their application to any course offered in the College, the latter shall prevail.

Abstract of the Courses for M.Sc programme on Aquaculture and Fish Processing

Semester	Course code	Course titles	Teaching hours	Credit	Total credits
I	16P1AQCT01	Taxonomy and Biology of commercial and cultivable fin fish and shell fishes	4	4	19
	16P1AQCT02	Biophysics, Instrumentation, Micro techniques and research methodology	4	4	
	16P1AQCT03	Biostatistics and computer application	4	4	
	16P1AQCT04	Aquaculture engineering	3	3	
	16P1AQCP01	Taxonomy and Biology of fin fish and shell fish	5	2	
	16P1AQCP02	Instrumentation, micro techniques, Biostatistics, Computer application and aquaculture engineering	5	2	
	CSE P1				
	Total		25	19	
II	16P2AQCT05	Ecology of culture systems and Aquatic biology	4	4	19
	16P2AQCT06	Biochemistry and Nutrition	3	3	
	16P2AQCT07	Physiology and pathology of fin fish and shell fish	4	4	
	16P2AQCT08	Genetics and Biotechnology	4	4	
	16P2AQCP03	Aquatic Biology, Physiology, Pathology and Genetics.	5	2	
	16P2AQCP04	Biochemistry and Nutrition.	5	2	
	CSE P2				
	Total		25	19	
III	16P3AQCT09	Culture of fin fishes, molluscs, and sea cucumbers	4	4	19
	16P3AQCT10	Aquariculture, aquaculture economics and Administration	4	4	
	16P3AQCT11	Culture of crustaceans, sea weeds and Post harvest technology	3	3	
	16P3AQCP05	Culture of fin fishes, molluscs, and sea cucumbers, crustaceans and sea weeds	5	3	
	16P3AQCP06	Aquariculture and aquaculture economics	5	3	
	16P3AQCP07	Post harvest technology and Quality Evaluation	4	2	
	CSE P3				
	Total		25	19	
IV	16P4AQCT12	Fishing Technology	4	4	23
	16P4AQCT13	Fish Processing Technology	4	4	
	16P4AQCT14	Fish Microbiology and Quality Assurance	4	4	
	16P4AQCP08	Fishing Technology	4	2	
	16P4AQCP09	Fish Processing Technology	5	2	
	16P4AQCP10	Microbiology and Quality assurance	4	2	
	CSE P4				
	16P4AQCPJ	Project		3	
	16P4AQCCV	Comprehensive viva voce		2	
Total		25	23	80	

Marks

I Semester Theory	400	Practical	100
II semester Theory	400	Practical	100
III Semester Theory	300	Practical	300
IV semester Theory	300	Practical	300
Project			100
Comprehensive viva			100
Total marks	1400		1000
Grand Total	2400		

SYLLABUS**16P1AQCT01 Taxonomy and Biology of Commercial and cultivable
Fin fish and shellfish.****Credit: 4****72hrs**

Module I: Morphology & Taxonomy of fin fish and shell fish	32hrs.
Study of external morphology of a typical elasmobranch, teleost, prawn, lobster, crab, bivalve, gastropod and cephalopod.	4hrs.
Study of scales, skin, teeth, mouth and fins and their use in taxonomy of fin fishes.	8hrs
Taxonomy of commercially important fin fishes of families of the orders: Clupeiformes, Perciformes, Cypriniformes, Siluriformes, Pleuronectiformes.	15hrs.
Taxonomy of commercially important shell fishes of prawns, crabs, lobsters, bivalves, gastropods and cephalopods in India.	5hrs.

Module2. Biology of fin fishes and shell fishes	30hrs.
Digestive system: Structure, function and physiology of digestive system and associated glands. Food and feeding habits of finfishes and shellfishes.	5hrs.
Respiratory system: Structure and function of respiratory system and accessory respiratory organs in fin fishes. Respiration in prawns and bivalves.	5hrs.
Circulatory systems: Structure and function of circulatory system, Blood, blood cells, plasma, plasma proteins.	3hrs.
Excretory system: structure and functions, osmoregulation in fishes and prawns.	2hrs.
Nervous system: Brain and nerves.	5hrs.
Endocrine system: Structure and function of endocrine glands of fishes. Neuroendocrine system of prawns. Role of hormone in relation to reproduction in fishes and prawns.	5hrs.
Reproductive system: Structure and function of reproductive systems of finfishes, prawns and bivalves. Gametogenesis- spermatogenesis and oogenesis, ovulation and fertilization.	
Gonadosomatic index. Parental care in fin fishes.	5hrs.

Module 3: Distribution of commercially important finfishes and shellfishes in Indian water	
Definition of mud banks, wedge bank and parr. Upwelling and its importance to fisheries.	
Distributional shifts of fishery stock, climate change.	10 hrs.

References:

1. J. R. Norman & W.P.C. Tenison. 1963 History of fishes. Asian Publishing Hse, Delhi
2. Karl F. Lagler, John e. bardach, Robert R. Miller 1969 Ichthyology. John Wiley & Sons, New York
3. Munro I.S.R. (1982) The Marine and Fresh water fishes of India and Ceylon. Sony Reprints Agency, New Delhi
4. Kapoor V.C.(1991) Theory and practice of Animal Taxonomy. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

5. Santhosh Kumar and ManjuTembhre (1996) Anatomy and Physiology of fishes. Vikas Publishing co.
6. Kotpal Mollusca
7. Kotpal. Arthropoda
8. EkambaranathIyer. Invertebrate Zoology
9. FAO species identification key.

**16 P1 AQCT02 Biophysics, Instrumentation, Microtechniques and
Research Methodology**

Credit: 4

72 hrs.

1. Biophysics:

16hrs.

Module 1 Diffusion and Osmosis

Diffusion, concentration gradient and Fick's Law, diffusion coefficient, stocks-Einstein equation, pressure gradient and Graham's Law, Gibbs-Donnam equilibrium. Osmosis, Vant Hoff's Law, Osmotic concentration and osmotic pressure, Biological significance of osmosis in fishes. 8 hrs.

Module II Biophysics of cell membrane: Physics-chemical properties of cell membrane, membrane receptors, factors affecting the passage of materials across cell membranes. 8hrs.

2. Instrumentation.

34hrs.

Module III Instrumentation: Calorimetry, spectrophotometry (U.V. visible, infrared and double beam), pH and, Oxygen probe, conductivity meter, salinometer and refractometer, atomic absorption spectrophotometer, Mass spectroscopy and LC-MS. 10hrs.

Module IV Protein purification : Basic methods involved in protein purification, Chromatography, absorption and partition chromatography, ion exchange and affinity chromatography, high performance (pressure) liquid chromatography, gel filtration chromatography. 8hrs.

Module V Electrophoresis :General principles and different gel materials for electrophoresis, different methods of electrophoretic techniques, Isoelectric focusing. 8hrs.

Module VI Microscopy: Principles of microscopy, bright field, dark field and phase contrast microscopy; fluorescence microscopy, microphotography, electron micrograph, principles of electron microscopy ultra structure studies using electron microscopy. 8 hrs.

3. Microtechniques

12hrs.

Module VII: Microtechniques: Fixation of invertebrates and vertebrates, tissues, organs. Dehydration methods, embedding, clearing and sectioning. Staining of sections, preparation of whole mounts. Histochemical methods for location of carbohydrates, lipids and protein fixation and processing of tissues for electron microscopy studies.

4. Research methodology:

10hrs.

Module VIII: Meaning and importance of research, Types of research-selection and formulation of research problem. Research design-need-features, different research designs, concepts relating to research design. Analysis of literature review, primary and secondary sources, web

sources-critical literature reviews.

3hr.

Module IX Data collection and analysis:

Collection of primary and secondary data, selection of appropriate methods of data collection, data preparation, important steps, types of analysis. 2

hrs.

Module X: Interpretation and report writing.

'Meaning of interpretation, techniques of interpretation, and precautions in interpretation.

Significance of report writing, different steps in report writing. Types of reports; technical and popular. Lay out of research reports, preliminary pages, main text, and end matter.

Reproduction of published materials-plagiarism-citation and acknowledgement, reproducibility and accountability. 5hrs.

References

Baker, E.J., and Silverion R.F., 1978. Introduction of Medical laboratory techniques ELBS.

Das, D. 1991. Biophysics and Biophysical chemistry. Academic publishers, Calcutta.

Ernster, L (ed.). 1985. Bioenergetics, Elsevier, New York

Foyer, C.H. 1984. Photosynthesis, Wiley, New York

Hoppe, W.*et al.*,(Eds.) Biophysics. Springer Verlag, Berline

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Roy, A.N. 1996. A test book of Biophysics, New Central Book agency Pvt. Lts. Calcutta.

Sadhu, G.S. 1990. Research Techniques in biological Sciences, Anmol Publications, New Delhi.

Weesner, F.M., 1960. General Zoological Microtechniques. The Willian and Willians Company, Baltimore.

16P1AQCT03**Biostatistics and Computer applications****Credit: 3****72 hrs.****Biostatistics.****42hrs.****Module I Collection, compilation and analysis of the data**

8 hrs

Primary and secondary data- formation of length and weight frequency distribution, measures of central tendency-Mean, median and mode.Measures of dispersion – range, quartile deviation, mean deviation and standard deviation. Absolute and relative measures of dispersion.

Module II Correlation and Regression analysis

8hrs

Scatter diagram- Karl Pearson's coefficient of correlation- Spearman's Rank Correlation coefficient-coefficient of determinationRegression analysis-Linear regression equations and their uses. Length –weight relationship and von Bertalanffy growth equation.

Module III Probability and Theoretical Distribution

10hrs

Frequency approach and Axiomatic approach to probability - Mutually Exclusive and independent events - Addition and Multiplication theorems - Binomial, Poisson and Normal distribution

Module IV Statistical quality control

6hrs

Process control and product control – control chart for variables and attributes – mean and range charts, fraction defective chart ('p' chart) and 'c' charts – sampling inspection plans.

Module V – Theory of sampling and inference

10hrs.

Population of sample, determination of the sample size – sampling techniques – estimation of marine fish landings in India. Null and alternative hypothesis-two types of errors in testing of hypothesis –large and small sample tests – 'Z', 't', X^2 and F-tests- Analysis of variance Techniques – Single factor – ANOVA

Computer Application**30hrs.****Module VI: Introduction to computers**

13hrs

Functions and components, characteristics of computers; generation of computers, types of computers. Computer system organization-Hardware and Software. Types of languages, programming concepts, memory (brief account only); recent developments in input-output devices, commercially used storage devices-hard disc floppy disc, CD, flash memory.Advances in microprocessor technology, Operating system-a comparative study.

Module VII -Computer and communications

17 hrs

MS Office, MS word, MS excel, MS power point, Photoshop, Page Maker.Network, internet, World Wide Web, email, www.Fishbase-org. P.h.stat.

References.

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- Saxena, S. 1998. A first course in computers, Vikas Publications House Pvt, Ltd. New Delhi.
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- Gupta, C.B.1996. An Introduction to Statistical methods. Vikas Publications House Pvt, Ltd. New Delhi.
- Srestha, H.B.1989. Elementary statistical methods, Orient Longman Ltd, Calcutta.

16P1AQCT04 Aquaculture Engineering**Credit: 4****72 Hrs****Module I Selection of Site****8 Hrs**

Selection of Site for aquaculture – Freshwater, brackish water and mariculture systems. General considerations, water quality, soil characteristics, biological aspects, topography, climatic factors, socio-political factors, infrastructure facilities.

Module II Surveying and Estimation of Area**8 Hrs**

Surveying – chain survey, plain table survey, contouring and leveling. Calculation of area of land by trapezoidal and Simpsons rule. Importance of engineering survey.

Module III Design of Farms**8 Hrs**

Design and construction of aquafarms – type of ponds, shape, size and their orientation from mereriological point. Design of various components of aquafarms – peripheral dykes, secondary dykes, feeder canals, drainage canals, water intake and outlet systems – seawater intake systems, sluice gate, monks and spillways. Calculation of earthwork for constructing ponds and requirement of water during water exchange.

Modul IV Soil**6Hrs**

Types of soil, different properties of soil, soil sampling methods, structure and textural classification, grain size distribution, bearing strength, prevention of erosion. Methods of soil compaction and seepage reduction.

Module V Design of Modern Aquaculture Systems**6 Hrs**

Design and construction of enclosures for mariculture operations, pens, cages, raceways, flow through systems and re-circulatory systems. Selection of materials for mariculture facilities. Sea farming, site selection and structures. Cage farming

Module VI Aquaculture Equipments**8 Hrs**

Equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection. Role of aeration in culture ponds.- paddlewheel aerators, cascade aerators, aspirators, compressors and blowers. Different types of pumps in aquaculture – vertical, centrifugal, jet and propeller pumps

Module VII Aquaculture Automobiles**6 Hrs**

Weed cutters and harvesters, bulldozers, excavators, rollers, refrigerated vans and mechanized fish harvesters.

Module VIII Hatcheries**8 Hrs**

Design of shrimp hatcheries – selection of site, source of water, water treatment. Disinfection, heating and cooling equipments in hatcheries. Design of hatchery building, water supply and drainage systems, inlets and outlets, aeration grid, FRP tanks, cement tanks and waste water treatment.

Module IX Aquaculture projects

8 Hrs

Preparation of aquaculture projects, estimation of efficiency, management of pond and hatchery machineries. New technologies in aquaculture engineering. Tank basins and other closed production unit.

Module X Feeding Systems

8 Hrs

Different types of feeding equipment – automatic and demand feeders, feed control systems, dynamic feeding systems. Adjustment of pH, removal of particles, Ammonia removal.

References.

1. Thomas B Lawson. Fundamentals of Aquaculture Engineering
2. Wheaton, F.W. Aquaculture Engineering
3. Santhosh Kumar Garg. Water supply Engineering
4. Bose *et. al.* Coastal Aquaculture Engineering
5. Odd-IvarLekang . Aquaculture Engineering
6. Pillay, TVR and Kutty. M N. Aquaculture: Principles and Practices
7. Michael B.T and Thomas L. Aquaculture water reuse systems
8. Syda Rao *et al.* Cage farming

16P1AQCP01

Taxonomy and Biology of finfish and shell fish

Credit: 2

72hrs.

Practical 1. Study on the morphology -scales, teeth, tails and fins of - commercially important Fin fish.

Practical 2. Study on the morphology of shell fishes-crustaceans and molluscs.

Practical 3. Dissection of alimentary canal and internal organs (Viscera) of a typical teleost fish.

Practical 4. Dissection of alimentary canal of a prawn.

Practical 5. Identification of commercially important fin fishes of the order Clupeiformes

Practical 6. Identification of commercially important fin fishes of the order Cypriniformes

Practical 7. Identification of commercially important fin fishes of the order Perciformes
(3 families)

Practical 8. Identification of commercially important fin fishes of the order Perciformes
(3families)

Practical 9. Identification of commercially important fin fishes of the order Perciformes
(3families)

Practical 10. Identification of commercially important fin fishes of the order Siluriformes
(3 families)

Practical 11. Identification of commercially important fin fishes of the order Siluriformes
(3 families)

Practical 12. Identification of commercially important fin fishes of the order Pleuronectiformes

Practical 13. Qualitative and quantitative analysis of gut contents. Index of preponderance.

Practical 14. Identification of commercially important crustaceans

Practical 15. Identification of commercially important molluscs.

Practical 16. Determination of gonadosomatic index, fecundity and its relationship with length and weight.

16P1AQCP02

Instrumentation, Microtechniques, Biostatistics, Computer application and Aquaculture engineering.

Credit: 2

72 hrs.

Module I Instrumentation:

22hrs.

Chromatography (Paper/TLC) for the separation and identification of amino acids.
Polyacrylamide gel electrophoresis/paper electrophoresis for the separation of proteins.
Conductivity meter, salinometer, refractometer demonstration.

Module II Microtechniques.

30hrs.

Micrometry, Phase contrast microscope, Camera Lucida, Micro photographic equipment.
Preparation of micro slides including whole mounts for evaluation during practical examination covering fixation, dehydration, clearing, embedding of tissues and preparation of blocks ,sectioning, affixing the section, staining and mounting, preparation of whole mounts.

Module III Biostatistics and computer applications.

15hrs.

Problems in tests of significance normal 1x2 and F. Basic concepts of sampling and estimation of marine fish landings, basic concepts in design of experiments.
Study of computer components: Microsoft Windows OS, MS word, MS Excel, MS Access, letter drafting and mail merging in computer. Use of internet and communication system.

Module IV Aquaculture Engineering

15hrs.

- 1) Visit to aquafarms and drawing the layout of ponds,dikes and sluices.
- 2) Earthwork Calculations
- 3) Calculation of daily and monthly water requirements.
- 4) General design for the construction of raceways, cages and pens.
- 5) General design of shrimp hatcheries.
- 6) Working of different aquaculture equipments
- 7) Grain size analysis of the soil.

SEMESTER II

16P2AQCT05

Ecology of culture systems and Aquatic Biology.

Credit: 4

72 hrs.

Module I: Physical and chemical characteristics of water: Role of physical parameters like depth, temperature, salinity, light, turbidity, and wind in ponds. Circulation and mixing patterns in ponds. Physical characteristics in relation to open sea farming.

Effect of monsoon on pond physical conditions. Seasonal and diurnal variation in pond. Chemical characteristics with reference to carbon dioxide system, dissolved oxygen distribution.

15 hrs.

Module II Aquatic Microbiology

Classification of Aquatic micro organisms. Sampling, isolation and purification of major groups of microbes from culture ecosystems. Identification and enumeration of major microbial groups, types of bacteria, fungi, actinomycetes in culture systems. Growth and reproduction in bacteria, microbial population in relation to physical, chemical and biological characteristics in ponds.

Pathogenic bacteria in culture systems. Role of microbes in regeneration of nutrients and hydrogen sulphide production in ponds, special groups of bacteria relevant in culture systems.

22hrs.

Module III Aquatic Biology.

Aerobic and anaerobic degradation of organic matter in pond bottom. Sludge accumulation, water quality management. Primary and secondary productivity in ponds, benthic productivity.

Macro and micro benthos including benthic algae in ponds. Ecological energetic of ponds. Effect of organic/inorganic fertilizers on pond productivity. Carrying capacity of culture systems. Lotic and lentic aquatic systems. Mud banks and monsoon trawling. Eutrophication.

15hrs.

Module IV Aquatic environment and Fisheries Oceanography.

Rivers of Kerala. Characteristics of estuaries, classification, horizontal stratification, estuarine communities, adaptation. Major estuaries of India. Physico-chemical characteristics of marine environment, classification thermal stratification, marine communities.

Objective, scope and relation to fishery science, major oceans, chemical composition of sea water.

20hrs.

References.

Pushpangadhan.P and Nair, K.S.S. 1997. Biodiversity and Tropical forests. State Committee for Science and Environment (STEC), Trivandrum.

Verma, P.S and Agarwal, V.K. 2001. Environmental Biology(Principles of Ecology). S.chand and Co. Ltd. New Delhi.

Elvira A. Baluyut.1989. Aquaculture systems and Practices. Daya Publication House, New Delhi.

Ramanujam, G.Guidelines Effluent treatments in shrimp farms. Aquaculture Authority, Govt. Of India, Chennai.

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Santhanam R. Ramanathan, N., Venketaramanujan, K., and Jagatheesan, G. 1987. Phytoplankton of the Indian seas. Daya Publishing House, Delhi

Keith Swerdup and Virginia Armbrust.2008. Introduction to the World's Oceans.

Krishna Iyer. 1958. Water Resources of Kerala. P.W.d.Kerala.

16P2 AQCT06: Biochemistry and Nutrition of fin fish and shell fish.**72 hrs****Credit: 3****Biochemistry**

32hrs

Module I: Prerequisites: Atoms, bonds, concepts of PH and buffers.**Carbohydrates:** classification, monosaccharides, reaction of monosaccharides with acid and alkali. Disaccharides, Oligosaccharides and Polysaccharides. 6hrs.**Module II: Lipids.** Classification, General properties, Oxidation, iodine number. Fatty acids: Classification of saturated and unsaturated, PUFA, MUFA, Simple lipids, Compound lipids phospholipids, Glycolipids, Spingolipids. Steroids, Cholesterol, Prostaglandins. Metabolism of lipids: fatty acid break down, fatty acid synthesis. 6hrs**Module III: Proteins.** Amino acids, structural organisation of proteins. Globular and fibrous proteins. Metabolism of proteins; metabolism of phenyl alanine, serine and glycine. Urea cycle. 7hrs.**Module IV: Enzymes.** Enzyme classification. Enzyme kinetics. Types of enzyme inhibition. Isoenzymes, co-enzymes. 7hrs.**Module V: Nucleic acids.** Bases and sugars. Nucleotides. Replication of DNA, transcription and translation process. 6hrs.**Nutrition****40hrs.****Module VI: Nutritional physiology.** Principles of nutrition. Adaptations to various types of feeding in finfish, crustaceans and molluscs. Mechanism of food capture, nutritional bioenergetics in finfish and shellfish.

8 hrs.

Nutritional requirements: Gross protein requirements, nitrogen balance; essential and non essential amino acids and their quantitative requirements, protein quality and sources; lipids, their functions; essential fatty acids, phospholipids and sterol requirements; protein sparing action of lipids, negative aspects of lipids, carbohydrates; their sources and utilization. 10hrs.

Water and fat soluble vitamins; their positive functions, minerals, recommended dietary allowances, deficiency and hyper dosage syndromes. 6 hrs.

Module VII: Feed ingredients Classification of feed stuff .Antinutritional factors in feed ingredients and their effect on finfish and shell fish. Additives in fin fish and shell fish.

Feed formulation strategies and methods. Feed manufacture process; storage and quality control of feeds. Larval nutrition- Nutritional requirements of finfish, crustacean and molluscan larvae.

Nutritive value of phytoplankton and their mass culture. Nutritive value of cladocerans and rotifers; their mass culture. Live and artificial feed , nutritive value of artemia ; their mass culture and cyst production; micro diets for larvae. Recent advances in larval nutrition. 10 hrs.

Module VIII: Feed management. Feeding strategies. Chemical methods of evaluation; biological methods of evaluation. PER,BV,NPU,NPR,FCR/ECR.Feed dispensing methods. 6hrs.

References

- Das, D. 2000. Biochemistry. Academic Publishers, Calcutta
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- Lakesh and Syed Ahamadhali (1985) Nutritional Quality of Live Food Organism and their enrichment ,CMFRISpl Pub .
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- Cowey, C. B. et al. (Eds)(1985), Nutrition and Feeding in Fishes ,Academic Press,London.

16P2AQCT07: Physiology and pathology of fin fish and shell fish

72 hrs.

Credit: 4

Physiology.

40hrs

Module 1: Physiology.

20hrs.

Physiology of respiratory, digestive, excretory and circulatory system. Osmoregulation. . Nervous system. Mechanism and biology of neuron co ordination.

Sense organs-receptive mechanisms and effector systems, biological rhythm. Ecophysiology, environmental requirements, effect of salinity, oxygen and other abiotic factors for metabolism. Molting and growth. Effect of environmental factors on acid base regulation and biotic interactions.

Module II: Endocrinology.

20hrs

General morphology, structure and function of neurosecretory system of crustaceans. Reproductive systems and secondary sexual characters, process of gametogenesis, neuroendocrine control of reproduction, hermaphroditism, parasitic castration, Neurosecretory and endocrine systems in fishes and shell fishes- their organization, morphology , structure of sinus gland complex . 'x' organ, 'y' organ and androgenic gland in crustaceans.. Pituitary and endocrine organs of fish, pituitary hormones- Their storage, release and control of reproduction.

Molting, growth and reproduction in crustaceans, induced maturation and spawning in finfish, crustaceans and mollusks, induced ovarian maturation and spawning through physical, chemical and biological method. New generation drugs, Hypophysation in finfish. Eyestalk ablation techniques-its principles and application in crustacean hatcheries.

Pathology.

32hrs.

Module I: Introduction. Definition of terms, classification of disease, causes of diseases, aetiology, role of abiotic and biotic factors, Intrinsic factors, generic, species and strain; extrinsic factors environment, nutritional status, role of stress in disease process.

Nonspecific immunity: agglutinin and precipitins, C-reactive protein, complement in fish, phagocytosis: acquired immunity; cell mediated immunity-Role of thymus, T-cell; receptors. Mechanism of cell mediated immunity, cytokines, T-helper function, role of macrophages, recirculation and ecotaxis of T-cell; T-cell markers.

Humoral immunity-origin of B-cell, differentiation of B-cells into plasma cells, T and B-cell interaction, antigenic stimulation; memory cells, structure of antibody; types of antibody; types of antibodies produced in fish. Immunization in fish and vaccination.

Basic vascular and cellular alterations, cell metabolism and cell growth, necrosis, inflammation; defenses of the body against injury, healing and neoplasms.

Microbial disease- Viral, Bacterial and Fungal Diseases and their control.

Parasitology.Parasitic diseases and their control

Nutritional disease, toxic diseases, prophylactic and control measures, biological and chemical treatment of disease.Integrated disease management.

References.

- Biswas.K.P (1992) ,Prevention and Control of Fish and Prawn Diseases, Narendra Publishing House,Delhi.
- Carl.J. Sinderman.(1997),Diseases Diagonosis and Control in North American Marine Aquaculture, Scientific Publishing co.New York.
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- Austin B and Austin D A (1987) Bacterial fish pathogens (Diseases in Farm and Wild), Lilies Horwood Limited.

16P2AQCT 08: Genetics and Biotechnology of Fin fish and Shell fish

72 hrs.

Credit: 4

Module I: Genetics.

40hrs

Introduction to Genetics. Practical application of Mendelian Genetics. Fish cytogenetics, principles of genetics techniques in cytogenetics. Evolution of fish Karyotypes sex linked genes and sex. Limited phenotypes, quantitative phenotypes, pleiotropy, recent trends in genetic mutations. Types of mutations and mutagens.

Gene expression and regulation.

Genetic improvement. Need for genetic improvement inheritance, inbreeding and cross breeding selection methods, basis of selection and its effects.

Hybridisation: Types of hybridisation, naturally occurring and artificially produced cyprinid hybrids. Cultural traits of hybrids.

Genetic manipulation: Sex-reversal and sex control, role of steroids in sex reversal, chromosomal manipulate, polyploidy. Androgenesis and Gynogenesis, cryopreservation of gametes, gametic manipulation. Genetic engineering: General principles of genetic engineering, recombinant DNA and gene cloning methods, restriction. Modification enzymes, PCR, sequencing, DNA, fingerprinting, recombinant vaccines, transgenic fish, gene transfer.

Module II: Biotechnology.

32hrs

Biotechnology in aquaculture. Introduction to tools and techniques in modern biotechnology.

Different types of probiotics. Use of probiotics and biofertilization in aquaculture. Immunostimulants used in aquaculture. Bioremediation in aquaculture systems. General principles of cell and tissue culture, culture of primary cells secondary culture (subcultures) and cell lines, Fish cell culture development of cell lines and their applications. Solid state Fermentation, disease diagnosis using PCR.

References.

Yadav, B.V. 1995. Fish Endocrinology, Daya Publishing House, New Delhi

Singh, R.P. 1990. Introductory Biotechnology, Central Book Depot, Allahabad.

Tiews, K (Eds.) Selection, Hybridisation and Genetic Engineering in Aquaculture. Heenemann, Berlin.

Das, P. and Jhingran A.G. (Eds.) Fish Genetics in India. 1989. Today and Tomorrows printers and publishers, new Delhi.

Gall G.A.E and Busack, C.A. (Eds.) 1986. Genetics in Aquaculture 2 Elsevier.

Collin E. Purdom 1993. Genetics and Fish Breeding. Chapman and Hall.

Menon and Pillai (Eds.) 2001 Perspectives in mariculture. The marine Biological Association of India.

Thomas, P.C. 1998. Shrimp Seed Production and Farming. Cosmo Publication.

16P2AQC P03: Aquatic Biology, Pathology, Physiology and Genetics.

72hrs.

Credit: 5

Module I. Aquatic Biology

Estimation of oxygen

Estimation of salinity

Determination of primary production.

Module II Aquatic microbiology

Isolation and cultivation of pathogenic bacteria in aquatic environment

Module II. Pathology

Study of various diseases finfish and shell fishes. Bacterial, fungal, viral and parasitic.

Identification of parasites. Treatment methods for fish diseases.

Module III Physiology

Dissection of neuroendocrine organs of a candidate species.

Module IV Genetics.

Demonstration of Preparation of chromosome from a fish.

16P2 AQC P04: Biochemistry & Nutrition

72hrs.

Credit: 2

Module I Biochemistry (Demonstration)

Colourimetric estimation of glycogen and glucose.

Estimation of soluble protein in fishes and prawns

Estimation of fish lipids

Proximate composition of fin fish and shell fish.

Estimation of soluble proteins, Biurete and Lowry's method

Module II Nutrition

Identification of common feed ingredients, Demonstration of determination of lipid quality and determination of moisture, lipid and ash in certain feed ingredients. Determination of crude protein, determination of gross energy of a few ingredients; feed formulation exercise; preparation of a compound feed

Preparation of purified diet for a prawn/fish (Demonstration).

SEMESTER III

16P3AQCT09: Culture of fin fishes, molluscs, and sea cucumbers **72 hrs.**

Credit: 4

Module I Fin fish culture

30hrs

Overview of fin fish culture in the world – major species cultured, country-wise production. . Fin fish culture in India- historical background and recent advances.

Marine, brackish water and fresh water species cultured, characteristics and criteria for selection of species for mariculture. Seed production, natural seed resources, their distribution, abundance, collection and transportation. Hatchery technology, brood stock management and breeding under controlled conditions. Induced breeding, egg incubation, larval rearing, and production of seed, nursery phase.

Different kinds of grow out culture systems, their advantages and disadvantages. Traditional and improvement farming practices. Operational details of monoculture and polyculture. Fin fish culture in pens and cages, raceways, running water systems, sea ranching of fin fish, integrated farming. Aquaponics.

Aquaculture Stewardship Council, Ecolabelling, Marine Stewardship council.

Module II Sea cucumber culture.

10hrs.

Present status of sea cucumber culture in the world. Natural resources and recent advances in breeding. Seed production, culture and conservation of sea cucumbers in India. Processing of sea cucumbers.

Module III Mollusc culture.

32hrs.

Overview of culture of Molluscs in the world. Major species of oysters, mussels, clams, cockles, scallops, gastropods in aquaculture.

Culture systems and principles. Modern development, their distribution and abundance, collection techniques.

Hatchery production of seed, brood stock management, induced maturation and spawning, larval rearing techniques, spat settlement and spat collection, water quality, disease control and transportation of seed.

Oyster farming-site selection, farm structure, farming techniques monitoring growth and condition index, control of predators and harvesting of edible oyster and pearl oysters.

Techniques of Mabe or image pearl production, pearl sac theory and pearl production.

Biofouling in oyster farms and control measures. Mussel culture methods. Harvest methods and sea ranching. Abalone culture. Depuration of bivalves, principles and methods.

References

Pillai T.V.R.(1988),Aquaculture Principles And Practices . Fishing News Books.

Naresh Kumar Agarwal (1996) Fish Reproduction ,APH Publishing Corporation ,New Delhi.

Pillai .T.V.R.(2005) Aquaculture Principles and Practices,Blackwell Publishing Ltd.

Menon.N.G. and Pillai.P.P (eds)(2001).Prespectives in Mariculture. The Marine Biological Association of india Publication.

James,P.S.B.R and Narasimham,K.A (1993).A Hand Book on Aqua Farming

Santhanam R Sukumaran.N and Natarajan .A(1987) A Manual of Fresh Water

Aquaculture.Oxward and IBH

CMFRI, Hatchery production of Pearl Oyster Spat: *Pinctada fucata* (1991) CMFRI Spl. Pub. Cochin
CMFRI, Hatchery Techniques and Culture of the Sea Cucumber *Holothuria scabra* (1994) CMFRI Spl. Pub, Cochin.
Sebastian C D and George Patani, Fish Culture in Ponds .Pookote Fisheries Kerala.
Dvey E B and M Graham Eds (1982) Bivalve Culture in Asia and Pacific .IDRC Asia Regional office ,Singapore.
Aquaculture in Asia (1990) Asian Fisheries Forum Indian Branch Mangalore Pillai T V R (1972) Coastal aquaculture in the Indo Pacific Region, Fishing News.
Bardach J E W (1972) Aquaculture Farming and Husbandary of Fresh Water and Marine Organisms.
Beveridge M C M (1987) Cage Aquaculture Fishing News
Miline P H (1972) Fish and Shell Fish Farming in China, Fishing News.
Santhanam R (1990) Coastal aquaculture in india CBS publications.
Larid L M and T Needham (Eds) (1988) Salmon and Trout Farming John Wiley and Sons
Sedgewick. S D (1990) Trout Farming Hand Book .Fishing News
Pillai T V R (1994) Aquaculture Development Progress and Prospects. Halsted press.
Artificial Reefs and Sea Farming Technologies (1996) CMFRI Bulletin no. 48
Transportation of live fish and shell fishes (1997) CMFRI Spl. Pub. No. 66
Boyd. C E and Pillai V K Water quality management in aquaculture 1985 CMFRI .Spl. Pub. 22.

16P3AQCT10:Aquariculture, Aquaculture Economics, Management and Administration. Credit: 4 72hrs.

Module I. Construction and maintenance of aquarium. 10hrs.

Aquarium construction and maintenance of marine and fresh water systems. Aquarium plants and filters.

Module II. Culture of aquarium fishes and management. 30hrs.

Fresh water aquarium fish culture. Marine aquarium fish culture. Marine ornamental fishes and ornamental invertebrates.

Breeding of Gold fish, Koi, Angel fish, barb, Fighter, Gourami, Livebearers, clown fish, Damsels, Butterfly fish, Seahorse.

Bulk production of ornamental fishes

Nutrition and feeds of aquarium fishes.

Establishment of a commercial ornamental fish culture unit.

Common diseases of aquarium fishes and management.

Module III. Economics. 20hrs.

Application of production economics in aquaculture. Law of diminishing returns; definition and application, marginal analysis-total products, average product, marginal product curves and formulae. Producer decision criteria, profit maximisation.

Cost fractions-determining maximum profit level of production, opportunity costs, fixed costs, variable costs, full costs, revenue function, total average marginal-production function in aquaculture. Investment financial planning and market analysis; investment-definition, autonomous and induced investment; choice and formulation of aquaculture investment projects, factors influencing investments and decisions, enterprise budget and partial for aquaculture enterprises. Income cash flow and statements. Ration analysis; supply and demand functions for aquaculture products. Consumer surveys for aquaculture products; market analysis and questionnaire design.

Module IV Aquaculture management. 12hrs.

Management of hatcheries and farms. Availability of manpower and skilled labour in India.

Personal requirements and management. Material management. Financial management.

Poaching and natural calamities. Water quality control for hatcheries and farms.

Criteria and nature of data input needed for preparation of feasibility reports on hatcheries and on fish feed mill.

References.

Lackey, RLTA Nielson 1980. Fisheries management Balckwell Sci. Pub. Oxford.

Panayotou, T. 1982. Management concept for small scale fisheries economic and social aspects. Fish.Technical paper No. 228 RME.

Peter W.Scot 1966. Complete Aquarium. Dorling Kindestey, London.

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16P3AQCT11: Culture of crustaceans, sea weeds and fisheries technology. 72 hrs.

Credit: 3

Module I Crustacean culture

Overview of crustacean culture in the world.

Major species cultured, technologies and problems of crustacean culture in India.

Historical background and recent advances; species cultured, potential species and characteristics of their suitability for aquaculture.

Shrimp/prawn seed production-natural seed resources, their distribution and abundance, collection and transportation, hatchery production of seed, brood stock management and breeding under controlled conditions, larval rearing techniques and mass production of seed.

Recent advances in seed production technology for crabs and lobsters, nursery phase.

Different kinds of grow out culture systems, traditional prawn culture practices and modern farming techniques; extensive, semi-intensive, intensive and super intensive shrimp farming, cages, pens and recirculating systems. Sea ranching of prawns. Specific Pathogen Free shrimp, culture of *Fenneropenaeus vannamei*.

Culture practices and potentials for crabs and lobsters. 35 hrs

Module II Sea weed culture

Taxonomy of economic seaweeds, seaweed morphology, reproduction and life cycle; growth of seaweeds and factors affecting it.

Seaweed culture in India- site selection, determining growth pattern and environmental monitoring; causes of mortality; small scale and commercial scale culture operations.

Utilization of seaweeds; post – harvest technology of cleaning, washing and storage; chemical composition of seaweed; processing and extraction of algin, alginic acid and alginates, processing and extraction of agar, mannitol and carrageen.

15hrs

Module III Microbiology

12 hrs.

Fundamental principles of bacteriology, -Morphology, size, reproduction and growth.

Bacterial spores, staining of bacteria, various staining methods Effect of environment on growth of bacteria-classification of bacteria.

Intrinsic and extrinsic parameters affecting microbial growth in food. Spoilage microorganisms of fish and fishery products. Psychrophilic and mesophilic microbes in processed fish and fishery products.

Module IV Fisheries Technology

10hrs.

Chemical composition of fish-lipids, protein, vitamins, minerals, non protein nitrogen compounds, carbohydrates, decarboxylation and deamination compounds.

Post mortem changes in fish –glycolysis, nucleotide degradation, catheptic enzymes, Principle changes following death of fish- autolysis, rigor mortis, autolytic enzymes.

Sensory evaluation of fresh fish

Iced storage- different types of ice and their production flow ice and gel ice.

Chilled storage- in ice, CSW,CFW,RSW,shelf life. Changes in fish during iced storage: physical, chemical, microbial and sensory changes.

Modified atmospheric packaging (MAP) and controlled atmospheric packaging (CAP).

Handling of fish on board, landing centers, retail outlets and pre processing centers.

Transportation of fish and containers used for transportation.

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Assurance in Sea Food processing CIFT

16P3AQCP05: Culture of fin fishes, molluscs, sea cucumber, crustaceans and sea weeds.

Credit: 3

72 hrs.

Module I

Identification of cultivable fin fish, Collection and identification of fish seed from nature., observe techniques of induced and larval rearing, field observation on culture operation of fin fish in ponds, Identification of cultivable species of sea cucumbers and their larvae. Visit to a sea cucumber farm. Observation on sea cucumber breeding and larval rearing techniques.

Module II

setting up of spat collectors, identification of nanoplanktors, estimation of growth and condition index in oysters. Pearl oyster surgery for nucleus implantation, depuration of oysters, field visit to a mussel or oyster farm and observe culture practices, collection and identification of foulers and predators in an oyster farm.

Module III

Observation of induced breeding, spawning and egg hatching and rearing of nauplius to post larvae, observation on prawn filtration practice , participation in modern prawn culture operation and assessing growth and production rates.

Identification of economic sea weed and their reproductive bodies. Field study of distribution and zonation of sea weeds , collection of sea weed material. Visit to small scale sea weed farm.

16P3AQCP06: Aquariculture and aquaculture economics.

72 hrs.

Credit: 3

Module I

Identification of economically important aquarium fishes, aquarium plants and invertebrates.
Construction and maintenance of aquarium, setting up of aquarium tanks.

Module II

Breeding and rearing of commercially important ornamental fishes in hatchery.
Live feed culture.

Module III

Preparation of schedule for collecting data on:

1. Market survey,
2. Field level data collection
3. Sampling examples of PCM/IRT/NPD.
4. Analysis and interpretation of data.

16P3AQCP07: Post harvest technology and quality evaluation of sea food.

72 hrs.

Credit: 2

Module I

Chemical evaluation of fresh fish and fish products.

Estimation of moisture, total nitrogen, non protein nitrogen, alpha amino nitrogen, trimethyl amine nitrogen and total volatile nitrogen. Ash.

Estimation of total fat. Free fatty acid value, peroxide value.

Microbial quality of fresh fish and changes in microbial quality on storage.

Laboratory techniques to detect and identify pathogens in fish-E.coli, Staphylococcus aureus, Streptococcus, Clostridium, Salmonella, Vibrio sp.

Sensory evaluation of fish and fish products.

Module II Post harvest technology

Handling of fresh fish,

Icing methods

Changes during chilled storage- chemical, microbiological and sensory.

Containers for fish transportation

16P4AQC T12: Fishing Technology Credit: 4 72 hrs.

Module I Fishing crafts.

Types of fishing crafts: traditional, motorized; different types in India
Outline of the method of construction of fishing boats in wood, fiber glass and Ferro cement and steel. 20hrs.

Module II Marine Fouling

Marine Fouling: Painting schedule, Maintenance of fishing boats.
Classification of corrosion; Marine corrosion and its control
Recent advances in fishing craft technology. 20 hrs.

Module III Fishing Gear

Classification of fishing gear system, Fishing gear materials and their properties.
Estimation of weight of netting.
Basic principles of gear design and capture mechanism. Fishing gear for closed water systems.
Nets: drag nets, shore sciences and light fishing. 22 hrs

Module IV Low energy fishing

Low energy fishing- Hooks and Lines, gillnets and Tangle nets, Cast nets, Trammel nets and Traps.
Responsible fishing: IUU, Bycatch reduction,
Turtle Exclusion Device. 5hrs.

Module V Basic Principles of Navigation.

Basic principles of navigation.
Fish finding devices- conventional and modern: fish aggregation devices
Recent advance in fishing gear technology. 5hrs.

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16P4AQCT13: Fish Processing Technology Credit: 4 72 hrs.

Module I - Freezing Technology of fish 25 Hrs.

Refrigeration, refrigeration load, refrigerants, cold storage of fish. Crystallization, Freezing curves for pure water and water in fish, physical and chemical changes on freezing, effect of freezing on location and size of ice crystals

Technological aspects of freezing: Slow freezing and quick freezing, Air blast freezing, tunnel freezing, fluidized bed freezing, spiral freezing, immersion freezing, contact plate freezing, cryogenic freezing and high pressure freezing.

Freezing on board fishing vessels, IQF freezers, selection of a freezing method, chemical, physical and sensory changes during freezing and frozen storage. Chemical treatment of fish prior to freezing, TTT and PPP factors, packing of frozen products, processing and freezing of frozen sea food products for export from India.

Module II Canning of fish. 15 Hrs

Principles of canning: Heat transfer in canned fish, thermal destruction of bacteria, D and D₀ value, F₀ value, Z value, determination of process time, cook value, Aseptic packing, containers for canning, unit operations, equipment used for canning, canning of sardine, tuna, and prawns. Retort pouch packaging. Waste management in canning industry, defects of canned product

Module III Curing and drying of fish 8Hrs

Water content and water activity, water activity and microbial spoilage, drying of fish, constant rate and falling rate drying period, salting and salting methods, drying methods for fish, packaging and storage. Quality problems and solutions. Maillard reaction, lipid oxidation, microbial, fungal and insects infestation. Packaging of dried products.

Smoking: objectives, smoke production, smoke components, quality, safety and nutritive value, processing and equipment, Freeze drying of fish. Accelerated freeze drying. Packaging of freeze dried products.

Module IV Fish Bye- products. 8 Hrs

Mince and surimi – Processing, packaging, freezing and storage. Fish protein concentrate, fish meal and oil, fish liver oil, fish hydrolysate, fish silage, Caviar, gelatin, glue, pearl essence, dehydrated jelly fish, squalene, fish maws and isinglass, Ambergris, Beche de mer.

Chitin, chitosan, and glucosamine hydrochloride, Utilization of prawn waste and fish processing waste. Processing and extraction of algin, alginic acid, alginates, agar, manitol, and carrangenan.

Module V Value added fish products 8 Hrs.

Coated fish products, batter, bread crumbs, general procedure for preparation of battered and breaded products, objectives, packaging and storage, equipment for making coated products, quality of coated products.

Types of coated products: coated fish fillets, fish fingers, coated shrimp products, moulded products, fish cutlets, fish balls, fish burger (patties). Seafood analogues and imitation products.

Module VI Other methods of preservation 8 Hrs

Fermented fish products, fish sauce, fish paste, fish sausage.

Radiation preservation, principles of radiation, ionizing radiations and their sources, units, applications of radiation, Shelf life extension, radappertization, radurisation, radicidation and radiation doses for irradiation of different fish products. Safety of irradiated fish. Hurdle technology.

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16P4AQCT14: Fish Microbiology and Quality Assurance

Credit: 4

72 hrs.

Module I Fish Microbiology

25hrs.

Native bacterial flora of fish, Microbes causing fish spoilage, Effect of low temperature, high temperature, salting, drying and hurdle technology on bacteria. Fecal indicator organisms and bacterial pathogens viz. Pathogenic *E.coli*, *S. aureus*, Salmonella, Shigella, Pathogenic Vibrios, *L. monocytogenes*, *Clostridium* etc. in fish and fishery products. Microbial analysis of water. Fish contact surfaces, fish and fishery products including isolation and identification of various bacterial pathogens. Biological hazards in seafood.

Module II Quality Control

20hrs.

General aspects of seafood quality and quality problems
Fish spoilage and quality assessment. Bacteriology of spoilage of fish and shellfishes
Fecal indicator bacteria in fish and bacteria of public health significance.
Salmonella in sea foods.
Seafood toxins.
Quality of water and ice for seafood processing
Trace metals in fish and shellfish
Good manufacturing practices in seafood processing.

Module III Quality assurance in seafood trade

27hrs.

Safety foods. End product quality and process control.
Hazards analysis and critical control points in sea food industry.
National and International standards for and fish products
Quality management and ISO 9000 series of standards. Waste management
Prerequisite programmes, SOP, SSOP, GMP, BUREAU OF INDIAN STANDARDS (BIS), Product traceability and recall. Sanitizers, Detergents, Cleaning agents and Disinfectants.

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16P4 AQCP08: Fishing Technology

72 hrs.

Credit: 2

Module I

Visit to net making factory-report

Netting twines, rope, netting, cutting, tailoring, mounting, design of nets

Module II

Visit to boat building yard- report

Boat building materials, back bone assembly, planking, maintenance of fishing boats, traditional and modern fishing vessels.

16P4AQCP09 : Fish Processing technology

72 hrs.

Credit: 2

Module I

Production of salted and dried fish.

Salting methods, drying methods.

Determination of moisture and salt content.

Production of frozen fishery products- dressed fish, fillets, minced fish, surumi,

Production of prawn products- whole prawns, HL, PUD, PD, Butterfly prawns.

Module II

Packaging of frozen prawns. Block frozen products, IQF products.

Freezing of marine products. Plate freezing, IQF freezing.

Production of canned products.

Product development. Fish cutlet, fish balls, fish burger.

Fishery by products. Fish meal, fish oil, chitin, chitosan, shark fin rays.

Fish pickle, smoked fish products,

16P4AQCP10: Microbiology and quality assurance

72 hrs.

Credit: 2

Evaluation of fish/fishery products for organoleptic, chemical and microbiological qualities.

Methods for analysis of bacterial quality and chemical parameters.

Water quality analysis. Colour, turbidity, odour, pH, dissolved solids, alkalinity, hardness, sulphate, chloride, metals like iron.

Bacteriological quality of water. Total plate count, coli forms, salmonella.

Evaluation of sanitary condition of fish processing plants.

Sensory evaluation of fish products.

Quality Evaluation of dried fish, canned fish and frozen products.

Effluent treatment (on site). Visit to Processing plant (ETP).

16P4AQCPJ: Project

Credit: 3

Total marks for Project =100

The split up of the marks is as follows.

- | | |
|---------------------------|-------------------|
| 1. Area of topic selected | = 5marks |
| 2. Introduction/Review | = 10marks |
| 3. Objectives | =5marks |
| 4. Materials and methods | = 10marks |
| 5. Results and discussion | = 15marks |
| 6. Conclusion | =5marks |
| 7. Bibliography | = 5marks |
| 8. Presentation | = 15marks |
| 9. Viva | = 5marks |
| Total | = 75 marks |

Test paper for research methodology _ 25 marks

Topic of test paper is Data collection(primary and secondary data)

Plagiarism and citation

Total marks for the project is 100.

16P4AQC CV Comprehensive Viva

Credit: 2

Total marks =100

The split up of 100 marks is as follows.

Questions from theory (4semesters)	=50 marks
Questions from practical(4 semesters)	= 15marks
Questions from seminar papers	= 10marks
General questions	= 5marks
Current topics	= 10marks
Overall impression	= 10marks.

Total marks =100marks

Certificate course in Ornamental Fish culture

Venue : Dept. of Aquaculture, S.H. College, Thevera

Duration : Three months (Average 300 hours)

Fees : Rs.10, 000/person

Qualification: those who are able to read and write.

Course modules

Module 1: Ornamental fish culture: Introduction.

Scope of ornamental fish culture- Hobby, livelihood option, self-employment, research, domestic market, export market, job opportunities, hatchery, public aquarium.

Varieties of fishes- Exotic and Indigenous. Exotic fishes. Gold fish, Angels, Live bearers, Cichlids, Gouramis, Catfishes etc. Indigenous fishes- barbs, catfishes, loaches etc. Present status

15hrs

Module 2: Aquarium setting

Glass tank construction: Glues to be used, different shapes and sizes. Cutting of glass, aquarium stand, and hood. Designer tanks, all glass tanks etc.

Aquarium setting: Accessories required, stocking density of fishes, how to select fishes, compatibility of fishes, feeding habits of fishes, aquarium maintenance, different types of filters to be used in aquariums, pumps, lights, plants, varieties of aquariums viz., planted aquarium, cichlid aquarium, gold fish aquarium etc. **15hrs.**

Module: 3. Ornamental fish breeding:

Breeding habits of fishes: Live bearers, Cichlids, carps, Gouramis, Barbs, Zebra etc.

Brood stock development, setting up of tanks for breeding the fishes for the different varieties of fishes. Facilities required for each variety of fishes, maintenance of water quality. **15 hrs.**

Module 4: Larval rearing and Live feed culture.

Food and feeding of the larvae of fishes. Live feed culture, Varieties of live feed, culture practices of live food organisms. Water quality maintenance for the maximum survival of larvae, Biosecurity issues, Diseases and treatment, quarantine, Best management practices etc.

10hrs.

Module 5. Packing and transportation.

Packing methods, stocking density, anesthetics used, precautions before packing. **5hrs.**

Module 6: Marketing.

Commercial production of fishes by setting up of hatchery- backyard hatchery, commercial hatchery Bank loans, subsidy schemes by different agencies like MPEDA, NFDB, Matsyafed, State fisheries Department, etc. **10hrs.**

Module 7: Aquatic plants.

Different Varieties of plants- floating, submerged, rooted, etc. Need of aquatic plants in aquariums. Culture of aquatic plants. Planting of aquatic plants in aquarium. Planted aquariums.

10hrs

Total theory 80 hrs.

Practical:

Breeding of Live bears 25hrs

Breeding of Cichlids 50hrs

Breeding of Gold fish/Koi	50hrs
Barbs/Zebra	25hrs.
Gourami fighter	25hrs
Live feed culture	20hrs
Packing of fishes	5hrs
Tank construction/setting.	20hrs.
Total Practicals	220hrs.

Grant total 300hrs.

Objective type Examination will be conducted at the end of the course for 100 marks.

Pass mark is 40 marks

Certificate of the college will be given.