PONDICHERRY UNIVERSITY
PUDUCHERRY

B.Sc. AQUACULTURE

(Choice Based Credit System)

Syllabus & Regulations

2023 ONWARDS

REGULATIONS

Choice Based Credit System

1. AIM OF THE COURSE

The degree of Bachelor of Science in Aquaculture (Choice Based Credit System) aims to introduce various aspects of Aquaculture and Fisheries subjects to the students. At the end of the course, the students are expected to have good working knowledge in the field of Aquaculture and Fisheries and in addition knowledge gained from courses of interdisciplinary in nature. The students of Aquaculture can acquire various opportunities in several central institutes such as CMFRI, CIFT, MPEDA, CIBA, NIO and various hatcheries and Fish processing plants in India and abroad.

2. ELIGIBILITY FOR ADMISSION

Candidate for admission to B.Sc. Aquaculture shall be required to have passed H.Sc. or 10+2 or equivalent course conducted by the Government of Tamil Nadu / Andhra Pradesh/ Kerala / CBSE with Botany / Zoology / Biology as one of the subjects of study or an examination accepted as equivalent thereto and 35 percentage of marks in part III (aggregate / part III), subject to such conditions as may be prescribed therefore. Maximum age for the duration into B.Sc. Aquaculture programme is 22.

3. DURATION OF THE COURSE

The course shall be of Three years duration spread over six semesters. The maximum duration to complete the course shall be six years (including the completion of arrears, if any).

4. ELIGIBILITY FOR ADMISSION TO EXAMINATION

Seventy-five (75) percentage of attendance for theory.
Seventy-five (75) percentage of attendance for practical

5. MEDIUM

The medium of instruction shall be English.

6. CHOICE BASED CREDIT SYSTEM (CBCS)

The Choice Based Credit System (CBCS) is being introduced in affiliated colleges of Pondicherry University for select UG courses. The system provides an opportunity to students to design curriculum to suit individual needs, mobility across related disciplines and institutions in both horizontal and vertical manner.

This System enables a student to obtain a degree in a subject by earning required number of credits prescribed for that degree. Number of credits earned by the student reflects knowledge or skill acquired and performance in each course is reflected in grades. The grade points earned for each course reflect the student's performance in that course.

The students should study prescribed courses like Discipline Specific Core Courses, Ability Enhancement Compulsory Courses, Skill Enhancement Courses, General Courses, etc. They are allowed to exercise choices in selection of courses that are Discipline Specific Elective Courses, General Electives, and Modern Indian Language etc., out of those offered by

departments within college or any other college/institution affiliated to Pondicherry University (PU) or any other PU recognized institutions. While allowing students to exercise choices, Pondicherry University notifies regulations by taking into account the practicality. Overall, CBCS is meant to promote student centric education instead of system centric education that is in vogue at present.

7. DEFINITIONS OF KEYWORDS

7.1 Programme: An educational program leading to award of a degree/ diploma/ certificate.

7.2 Programme Committee: Each Program of Study shall have a Programme Committee to oversee implementation of the program.

7.3.1 Course: Usually a course referred to as 'subject' is a component of the Programme of Study. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/term papers/assignments/ presentations/ self-study etc., or a combination of some of these.

7.3.2 Core Course: There shall be Core Courses in the first four semesters. These courses shall be compulsorily studied by a student.

7.3.3 Elective Course: Elective Course is a course which can be chosen from a pool of papers. It may be:

- Supportive to the discipline of study
- Providing an expanded scope
- Enabling an exposure to some other discipline/domain
- Nurturing student's proficiency/skill.

An elective may be "Generic Elective" focusing on those courses which add generic proficiency to the students. An elective may be "Discipline Centric" or may be chosen from an unrelated discipline. It may be called an "Open Elective."

7.3.4 Foundation Course: The Foundation Courses may be of two kinds: Compulsory Foundation and Elective foundation. "Compulsory Foundation" courses are the courses based upon the content that leads to Knowledge enhancement. They are mandatory for all disciplines. Elective Foundation courses are value-based and are aimed at providing ethicaland humanistic education.

7.3.5. Repeat Course: If a student gets (i) less than 40% in the internal assessment and failsin the course or (ii) fails to get the required attendance, the student shall repeat the course when offered.

7.4. Choice Based Credit System (CBCS): The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses etc.). Under the CBCS, the requirement for awarding a degree / diploma / certificate is prescribed in terms of number of credits to be completed by the students.

7.5 Credit: It is a unit by which the course work is measured. It determines the number of hours of instructions required per week:

Course Name	Credit	Hours of instruction	Weightage (credit/ hours)
MIL	1	1.5	0.66
ENGLISH	1	1.5	0.66
DSC (Theory)	1	1	1.0
DSC (Practical)	1	2	0.5
GEN	1	1.5	0.66
SEC	1	1	1
DSE (Theory)	1	1	1
DSE (Practical)	1	2	0.5
GE	1	1.3	0.75

7.6 Letter Grade: It is an index of the performance of students in a said course.
Grades are denoted by letters O, A+, A, B+, B, C, P and F.

7.7 Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

7.8 Credit Point: It is the product of grade point and number of credits for a course.

7.9 Semester Grade Point Average (SGPA): It is a measure of performance of work done in a semester. SGPA is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. Itshall be expressed up to two decimal places.

7.10. Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

7.11 Transcript or Grade Card or Certificate: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

7.12 Academic Year: Two consecutive (one odd + one even) semesters constitute one Academic year.

7.13 Semester: Each semester consists of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to December and even semester from January to June.

8. SCOPE AND COVERAGE

8.1 The CBCS is applicable to all full-time UG Biotechnology approved by the Academic Council.

8.2 Teaching, learning and evaluation shall follow Semester pattern.

8.3 Students who have passed their Higher Secondary Examination under 10+2 system conducted by the Government of Tamil Nadu/Kerala or any other equivalent system recognized by the Government of Puducherry based on the admission criteria laid down by Pondicherry University are eligible to apply to B.Sc. Aquaculture. The exact eligibility criteria will be as prescribed in the regulations approved by the Academic Council of Pondicherry University on the recommendation of the BOS of the respective Departments from time to time.

8.4 Prescribed B.Sc. Aquaculture consists of six consecutive semesters (three years). The maximum duration allowed for each student to acquire prescribed number of credits in order to complete the Programme of Study shall be twelve consecutive semesters (six years).

8.5 The academic year consists of two consecutive (one odd and one even) semesters.

8.6 The medium of instruction for all the courses, excepting Arabic, Bengali, French,Hindi, Malayalam, Sanskrit, Tamil, and Telugu, shall be English.

9. COURSE STRUCTURE

At least 60% (72 Credits) of the total minimum credit requirement must be earned by the student in DSC and DSE courses put together in order to obtain a degree in a specific discipline.

10. CREDITS

10.1 One teaching period shall be for 60 minutes duration.

10.2 The minimum number of credits to be earned by a student for the award of B.Sc. Aquaculture is 120**.** Out of these, minimum 72 credits are mandatory from Discipline Specific Core Courses (DSC) and Discipline Specific Elective Courses (DSE) put together for obtaining a degree in a particular discipline. The minimum number of credits in each semester is 20. All together in six semesters a total of 132 credits are offered for the students who can select the courses under CBCS for the final 120 credits for the award of B.Sc. Aquaculture Degree.

11. REGISTRATION

11.1 Every student will be assigned a Faculty Advisor after his/her completion of admission procedure.

11.2 Based on the advice and consent of the Faculty Advisor the student shall register for a set of courses that he/she plans to take up in each semester from among those denoted by the Principal/ HOD.

11.3 The student must take the consent of the course teacher offering course(s) for registration.

11.4 The student is permitted to register for courses not exceeding 30 credits per semester.However, registration for Repeat Courses is allowed in excess of this limit.

11.5 A student, in order to retain his/her status, should register for at least a minimum of 12 credits in a semester.

11.6 Students shall have to register for the courses within the first week of a semester.

11.7 The maximum number of students to be registered in each course shall depend upon the physical/ laboratory facilities available.

11.8 The information concerning the courses to be offered in every department in a semester with credits and pre-requisites, if any, along with the time-slot shall be made available by the Aquaculture Department of the Institution.

11.9 A student shall not be denied registration for whom the courses are Discipline SpecificCore Course (DSC) or Discipline Specific Elective (DSE).

11.2 The registration for all other courses shall be done in the spirit of accommodating as many students as possible in the interest of the students.

11.13 Dropping of courses may be allowed to enable students to opt for the courses of their choice within three weeks from the date of registration.

12. INTRODUCTION OF COURSES

12.1 The course code consists of four alphabets representing the discipline of study followed by three numerals. The first numeral '1' stands for level/ year of the course (year of collegiate education), 2 for second year course and 3 for third year course. The second numeral stands for semester (odd or even) and the third numeral is for the serial numberof the course.

12.2 The Course Structure and Syllabus for each UG programme shall be finalized and recommended by the Board of Studies (BOS) to be placed in the School Board, and then, in the Academic Council, for consideration and approval.

12..3 The syllabi of B.Sc. Aquaculture course shall be revised at least once in three years, to keep in tune with recent developments in knowledge and innovations. Minor revisions in the already approved syllabus of a particular course may be approved by the Chairman of the Academic Council provided there is proper justification and recommendations by the Chairpersons of the BOS and School Board.

13. WORKLOAD OF TEACHERS

13.1 Every faculty member shall be assigned workload as per UGC norms.

13.2 In addition to regular handling of classes, teachers are required to participate in preparation of detailed syllabus, designing of the teaching plan, invigilation, paper setting, evaluation of answer scripts during continuous assessment and any other duties as and when assigned by the Principal or University authorities.

13.3 Teachers shall associate with organizing practical lab sessions, field visits, industrial tours, and guided project work etc., as per directions of the Principal/ Head of the institution.

14. PATTERN OF EXAMINATION

14.1 The End-Semester examination (**ESE**) for each course in B.Sc. Aquaculture shall be conducted by the Pondicherry University for a maximum of **75 marks** and Internal Continuous Assessment (**ICA**) for **25 marks.**

14.2 Internal assessment for all theory courses shall be done on the basis of at least two Internal Assessment tests (15 marks), term papers/assignments/seminars/case demonstrations/ presentations/ write-ups/viva etc. (5 marks) and attendance (5marks). The following weightage shall be given to attendance:

95% - 100% (5 marks)

90% - 94% (4 marks)

85% - 89% (3 marks)

80% - 84% (2 marks)

75% - 79% (1 mark)

14.3 Internal Assessment for practical courses involving Laboratory/Field work/Project work is 13, marks for Practical Record is 10, 27 marks for Practical end-semester exam.

14.4 A schedule of Internal Assessment tests shall be prepared by each College commonly to all departments in the beginning of each semester. Internal Assessment marks shall be displayed a week before the commencement of end-semester examinations.

14.5 End-semester examination shall be conducted for all courses offered. The duration of the end-semester examination shall be 3 hours.

14.6 Every student has to pay examination fee per Credit basis as fixed by the University.

14.7 A schedule of end-semester examinations will be prepared and displayed by the University much in advance.

14.8 No student with less than 75% in any particular course shall be permitted to attend the end-semester examination and shall be given grade FA-failure due to lack of attendance. However, an overall condonation of 10% is permitted for valid reasons (NCC, NSS, Swachh Bharat) or medical reasons. A student who has been awarded FA shall repeat the course when offered. The Principal/ Head of the Department shall ensure that the candidate is informed about the lack of attendance before the commencement of end-semester examination and confirm that such candidates are not permitted to write the examination.

14.9 To pass a course the student must secure minimum of 40 out of 100 marks (40%) in the internal and the end-semester examination put together.

14.10 A student who has earned the required number of 120 credits by clearing all the required courses shall be declared as pass even if he/she could not clear optional courses which were taken in excess of the required number of courses.

14.11 Result Passing Candidate for admission to B.Sc. Biotechnology shall be required to have passed H.Sc. or 10+2 or equivalent course conducted by the Government of Tamilnadu / Andhra Pradesh/ Kerala / CBSE with Botany / Zoology / Biology as one of the subjects of study or an examination accepted as equivalent thereto and 35 percentage of marks in part III (aggregate / part III), subject to such conditions as may be prescribed therefore. Maximum age for the duration into B.Sc. Biotechnology programme is 22. Board for each Programme of Study shall be constituted by the Pondicherry University from time to time.

14.12 Revaluation and re totaling of the answer scripts shall be allowed within the stipulated period of time as decided by the Controller of Examinations (COE) after paying the required amount of fee.

15. SUPPLEMENTARY EXAMINATION

15.1 A failed student who meets the attendance requirement may be permitted to register for the next end-semester examination in the following semester itself for theory paper. (eg. for practical papers, those who failed in odd semester practical paper may be permitted to register for next odd end-semester examination).

15.2 Students who have failed due to insufficient attendance and /or less than 40% Internal Assessment marks should repeat the course as and when offered.

16. PROGRAMME COMMITTEE

16.1 The Programme Committee (PC) of each department shall be chaired by the Principal /Head of the institution. The HOD, all the faculty members offering DSC and DSE course and two students (one male and one female, where possible) from each class shall be Members of PC.

16.2 The PC shall meet at least once in a semester to discuss implementation of the program. The discussions and resolutions should be on adherence to time-table, proper syllabus coverage, introduction of new courses and all other issues concerning academic matters.

16.3 The minutes of the PCM must be communicated to the Chairman of BOS, Controller of Examinations and Dean, College Development Council of Pondicherry University.

17. GRADING AND GRADE CARD

17.1 Letter grades shall be used to assess the performance of students in each course by converting final marks (out of 100) into grades. In case of fractions the marks shall be rounded off to next integer. The following shall be used to convert marks into awarding grades:

Range of Marks	Letter Grade	Grade Point
96-100	0	10
86-95	A+	09
76-85	A	08
66-75	B+	07
56-65	B	06
46-55	C	05
40-45	P	04
Below 40	F	00
Lack of attendance	FA	00

17.2 The SGPA shall also be calculated by taking all courses taken by the student in the semester and CGPA shall also be calculated by taking all the courses taken by the student inall the semesters (refer 16and 17).

17.3 The University shall award "class" to students who acquired 120 (see 5.6) according tothe following:

CGPA	Class
9.00 – 10.00	First Class with Distinction (should not have failed in any course)
7.00 – 8.99	First Class
5.50 – 6.99	Second Class
4.00 – 5.49	Pass

17.4 The Grade card shall be issued to the students containing grades obtained by the student in the previous semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA).

The Grade card shall list the following:

a. Title of the course taken by the student
b. Number of credits allotted to the course
c. The grades secured by the student in each course
d. Total number of credits earned by the student in that semester
e. SGPA of the student
f. Total number of credits earned by the student till that semester
g. CGPA of the student

18. FAIRNESS IN ASSESSMENT

To ensure fairness of examination and evaluation following shall be followed.

18.1 In case of at least 50% of core courses offered in different programmes across the disciplines, the assessment of the theoretical component towards the end of the semester should be undertaken by external examiners from outside the university conducting examination, who may be appointed by the Controller of Examinations. Insuch courses, thequestion papers will be set as well as assessed by external examiners.

18.2 In case of the assessment of core practical courses, the team of examiners should be constituted on 50 – 50 % basis. i.e., half of the examiners in the team should be invited fromoutside the University for conducting examination.

18.3 In case of the assessment of project reports / thesis / dissertation etc. the work should be undertaken by internal as well as external examiners.

19. COMPUTATION OF SGPA AND CGPA

Following procedure to compute the Semester Grade Point Average (SGPA) and CumulativeGrade Point Average (CGPA) shall be followed:

19.1 The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$\textbf{SGPA (Si)} = \Sigma (Ci \times Gi) / \Sigma Ci$$

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the course.

19.2 The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \Sigma (Ci \times Si) / \Sigma Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

19.3 The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

20. ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA AND FORMAT FOR TRANSCRIPTS

20.1 Computation of SGPA and CGPA

Illustration 1 for calculation of SGPA

The illustration is for a student who has taken six courses of given credits in a semester and performance is given in grade letter which carry certain grade point.

Course	**Credit**	**Grade letter**	**Grade point**	**Credit Point (Credit x Grade point)**
Course 1	3	A	08	3x08 = 24
Course 2	4	B+	07	4x07 = 28
Course 3	3	B	06	3x06 = 18
Course 4	3	O	10	3x10 = 30
Course 5	3	C	05	3x05 = 15
Course 6	4	B	06	4x06 = 24
20				**139**

SGPA = 139/20 = 6.95

20.1.2. Illustration 2 for calculation of SGPA

A student registered for 6 (six) courses in a semester. At the end of the semester the student got A grade in a 4 credit course, A grade in 2 credit course B+ in a 3 credit course another B+ in a 3 credit course, B in a 3 credit course and F grade in a 3 credit course. Calculation of SGPA of this student is:

SGPA = (8x4+8x2+7x3+7x3+6x3+0x3)/(4+2+3+3+3+3) = (32+16+21+21+18+00)/18= 108/18 = 6.00 0ut of 10.00.

SGPA of the student is 6.00.

20.1.3 Illustration for calculation of CGPA (Example)

The illustration is for calculation of CGPA of a student who studied six semesters in a UG program.

Semester	**Credits**	**SGPA**
Semester 1	20	6.95
Semester 2	22	7.80
Semester 3	18	5.65
Semester 4	21	6.04
Semester 5	19	7.21
Semester 6	20	7.85
Total = 120		

CGPA =

(20 x 6.95 + 22 x 7.80 + 18 x 5.65 + 21 x 6.04 + 19 x 7.21 + 20 x 7.85) divided by 120	= 139.00 + 171.60 + 101.70 + 126.84 + 136.99 + 157.00 = 833.13/120 = 6.94275 Rounded off to 6.94

CGPA = 6.94. The student has passed in the program and is placed in 2nd Class.

20.2 Transcript: The University shall issue a transcript for each semester as given in 14.7and a consolidated transcript indicating the performance in all semesters.

COURSE STRUCTURE FOR B.SC. PROGRAMME IN AQUACULTURE

SEMESTER I 23 credits					
Sl No.	**Course**	**Course Code**	**Title**	**Hr/Week**	**Credits**
1	MIL-1	LARA/LHIN/ LMAL 111	Arabic/Hindi/Malayalam	5	3
2	ENGLISH-1	ENGL 112	English-I	5	3
3	DSC-1A	UAQC 111	Taxonomy of Fishes	4	4
4	DSC-2A	UAQC 112	Basic Principles of Aquaculture	4	4
5	DSC-3A	UAQC 113	Invertebrate Zoology	4	4
7	AECC-1	COMP 113	Computer Application	2	2
8	Practical	UAQC 111 (P)	Taxonomy and Fishing Technology	2	1
9		UAQC 112 (P)	Field Visit and Specimen Collection	2	1
10		UAQC 113 (P)	Invertebrate Zoology	2	1
TOTAL				**30**	**23**

SEMESTER II 23 credits					
Sl No.	**Course**	**Course Code**	**Title**	**Hr/Week**	**Credits**
1	MIL-2	LARA/LHIN/ LMAL 121	Arabic/Hindi/Malayalam	5	3
2	ENGLISH-2	ENGL 122	English-II	5	3
3	DSC-1B	UAQC 121	Breeding and Rearing of Aquarium fishes.	4	4
4	DSC-2B	UAQC 122	Ecology of Aquatic Environs	4	4
5	DSC-3B	UAQC 123	Vertebrate Zoology	4	4
7	AECC-1	BIOD 123	Biodiversity – Conservation and Management	2	2
8	Practical	UAQC 121 (P)	Breeding and Rearing of Aquarium fishes.	2	1
9		UAQC 122 (P)	Water Quality Assessment	2	1
10		UAQC 123 (P)	Vertebrate Zoology	2	1
TOTAL				**30**	**23**

Semester III 23 credits					
Sl No.	**Course**	**Course Code**	**Title**	**Hr/Week**	**Credits**
1	GEN 1	RESM 211	Research Methodology	5	3
2	GEN 2	NRM 212	Natural Resources Management	5	3
3	DSC-1C	UAQC 231	Aquaculture of Freshwater Fishes	4	4
4	DSC-2C	UAQC 232	Biology of Fishes	4	4
5	DSC-3C	UAQC 233	Evolution and Conservation Biology	4	4
7	SEC-1	UAQC 234	Pond Preparation & Management	2	2
8	Practical	UAQC 231 (P)	Farm Management	2	1
9		UAQC 232 (P)	Biology of Fishes	2	1
10		UAQC 233 (P)	Evolution and Conservation Biology	2	1
TOTAL				**30**	**23**

Semester IV 23 Credits					
Sl No.	**Course**	**Course Code**	**Title**	**Hr/Week**	**Credits**
1	GEN 3	CRM 221	Coral Reefs and Mangroves – Ecology and Conservation	5	3
2	GEN 4	OCEA 222	Oceanography	5	3
3	DSC-1D	UAQC 241	Mariculture	4	4
4	DSC-2D	UAQC 242	Seafood Processing Technology	4	4
5	DSC-3D	UAQC 243	Genetics and Molecular Techniques	4	4
7	SEC-2	UAQC 244	Seminar, Exhibition, setting Aquaria	2	2
8	Practical	UAQC 241 (P)	Live Feed,, Culture, stock culture maintenance	2	1
9		UAQC 242 (P)	Seafood Processing Technology	2	1
10		UAQC 243 (P)	Genetics and Molecular Biology	2	1
TOTAL				**30**	**23**

Semester V 20 Credits					
Sl No.	**Course**	**Course Code**	Title	**Hr/Week**	**Credits**
1	SEC 3*	UAQC 351	Value Addition to Fishery Products	2	2
		UAQC 352	Biofuel Technology/Seaweed culture	2	2
2	DSE-1A** DSE-2A** DSE-3A**	UAQC 353	Aquaculture Engineering	6	4
3		UAQC 354	Hatchery Technology of Aquatic organisms.	6	4
4		UAQC 355	Crafts and Gears	6	4
5		UAQC 356	Marine Biology	6	4
6		UAQC 357	Marine Resource Management & Ecosystem Services	6	4
7	GE-1	UAQC 358	Biostatistics	4	3
8	PROJECT -1	UAQC 353 (Pr)	Industrial training/Study Tour		
9	PROJECT -2	UAQC 354 (Pr)	Project	2	1
10	Practical	UAQC 355 (P)	Value Addition to Fishery Products	2	1
11		UAQC 356 (P)	Biostatistics and Computer Application	2	1
TOTAL				**30**	**20**

Semester VI 20 Credits					
Sl No.	**Course**	**Course Code**	**Title**	**Hr/Week**	**Credits**
1	SEC 4*	UAQC 361	Bioinformatics	2	2
		UAQC 362	Herbarium Preparation of Marine Plants	2	2
2	DSE-1B** DSE-2B** DSE-3B** DSE-4B**	UAQC 363	Fish Pathology and Health Management	6	4
3		UAQC 364	Fisheries Economics and Extension	6	4
4		UAQC 365	Genetics and Biotechnology In Aquaculture	6	4
5		UAQC 366	Aquatic Microbiology	6	4
6		UAQC 367	Planktanology and Algology	6	4
7	GE-2	UAQC 368	Marine Drugs and Bioprospecting	4	3
8	PROJECT -3	UAQC 364 (Pr)	Project	2	1
9	Practical	UAQC 365 (P)	Aquatic Microbiology	2	1
10		UAQC 367 (P)	Planktanology and Algology	2	1
TOTAL				**30**	**20**

DSE** - Any 3 in semester V & VI

SEC* - Any 1 in semester V & VI

Total Number of Credits - 132

Course code ending with (P) denotes practical paper.

Course code ending with (Pr) denotes project paper.

B.Sc. AQUACULTURE	Course with Credit							
Semester	**MIL**	**ENG**	**GEN**	**DSC**	**DSE**	**SEC**	**AECC**	**GE**
I	01	01		03	-		01	
II	01	01		03	-		01	
III	-	-	02	03		01	-	
IV	-	-	02	03		01	-	
V	-	-		-	03	01	-	01
VI	-	-		-	03	01	-	01
Total	**02**	**02**	**04**	**12**	**06**	**04**	**02**	**02**
Total No. of Papers	**34**							

DETAILS OF COURSES FOR B.Sc. AQUACULTURE

I. **DSC 1** - **DISCIPLINE SPECIFIC CORE** – (AQUACULTURE main)
(COMPULSORY) (Twelve papers in first four semesters)

1. Taxonomy of Fishes
2. Basic Principles of Aquaculture
3. Invertebrates Zoology
4. Breeding and Rearing of Aquarium fishes.
5. Ecology of Aquatic environs
6. Vertebrates Zoology
7. Aquaculture of Freshwater Fishes
8. Biology of Fishes
9. Evolution and Conservation Biology
10. Mariculture
11. Seafood Processing Technology
12. Genetics and Molecular Techniques

II. **SEC- SKILL ENHANCEMENT COURSES** (also for non-Aquaculture main)
(Four papers – one paper each in III, IV, V & VI Semester. V & VI Semester there will be twochoices)

1. Pond preparation & Management
2. Seminar, Exhibition, Setting Aquaria
3. Value Addition to Fishery products

4. Biofuel Technology /Seaweed culture
5. Bioinformatics**
6. Herbarium Preparation of Marine Plants**

III. DSE - DISCIPLINE SPECIFIC ELECTIVES

DSE-1A, 2A, 3A &4A (Three papers – V Semester)

1. Aquaculture Engineering
2. Hatchery Technology of Aquatic organisms.
3. Crafts and Gears
4. Marine Biology
5. Marine Resource Management & Ecosystem Services

DSE-1B, 2B & 3B (Three papers –VI Semester)

1. Fish Pathology and Health management
2. Fisheries Economics and Extension
3. Genetics and Biotechnology in Aquaculture
4. Aquatic Microbiology
5. Planktanology and Algology

IV. **GE - GENERIC ELECTIVE** (also for non-Biotechnology main)

GE - 1
Biostatistics.
GE - 2
Marine Drugs and Bioprospecting

V. MIL - MODERN INDIAN LANGUAGES

Arabic/ Bengali/ Hindi/ Malayalam/ Sanskrit/ Tamil/ Telugu

VI. ENGLISH

VII. **AECC- ABILITY ENHANCEMENT COURSES**- (COMPULSORY)

1. Computer Application
2. Biodiversity – Conservation and Management

VIII. **GEN – General Course**s (COMPULSORY)

1. Research Methodology
2. Natural Resource Management
3. Coral Reefs and Mangroves – Ecology and Management
4. Oceanography

IX. PRACTICAL/PROJECT (COMPULSORY)

DISCIPLINE SPECIFIC CORE COURSES
(COMPULSORY)

Course: DSC-1A **Course Code : UAQC 111**

Title: TAXONOMY OF FISHES

Hrs/Week: 4 **No. of Credits:4**

Unit I:

Basic principles of taxonomy and phylogeny: History of taxonomy, nomenclature. International Code of Nomenclature: salient features, principles, important rules and recommendations, Provisions for the governance of the Code. Taxonomic hierarchy. Levels of taxonomy, Alpha, Beta and Gamma taxonomy. Type concepts.

Unit II:

Conventional taxonomic methods – morphological characteristics, morphometric measurements and meristic counts - truss morphometry. Use of dichotomous keys for identification. Modern taxonomical tools, Karyotyping, DNA Barcoding

Unit III:

Concept of Evolution. Lamarckism, Darwinism, Natural selection, Neo-Darwinism and Mutation theory. Variations- nature and types. Mechanisms that decrease and increase variations (natural selection, genetic drift, mutation, recombination and gene flow). Speciation: modes of speciation – allopatric/sympatric speciation, eco-phenotypic variation, isolating mechanisms, speciation in time.

Unit IV:

Macro and micro-evolution: definitions, mechanisms and importance. Phylogeny: introduction and concepts of phylogeny. Phylogenetic trees, cladistics and phylogenetic reconstructions, hierarchy of species, transitional forms and molecular phylogeny.

Unit V:

Shellfish and finfish taxonomy. Taxonomic characters of molluscs, decapods crustaceans (prawns and crabs) and teleosts. Classification up to families. Collection, preservation, labeling and curation methods of major phyla: Sponges, annelids, molluscs, arthropods, echinoderms, fishes.

Unit VI

Major riverine, reservoir and estuarine fisheries. Marine fisheries- pelagic (sardines, mackerel, anchovies, ribbon fishes, tuna, seer fishes) and demersal (elasmobranchs, cephalopods, silver bellies, flat fishes, crabs, sciaenid's, pomfrets, Bombay duck, prawns, lobsters, molluscan resources).

Text books and References

1. Crist, D.T. Scowcroft, G. and Harding Jr., J.M. 2009. World Ocean Census; a Global Survey of Marine Life, Firefly Books, New York: 256 pp.
2. Guido di Prisco, Peter Convey (auth.), Guido di Prisco, Cinzia Verde (eds.). 2012. Adaptation and Evolution in Marine Environments, Volume 1: The Impacts of Global Change on Biodiversity. Springer-Verlag Berlin Heidelberg 236 pp.
3. Quicke, Donald L.J. 1993. Principles and Techniques of Contemporary Taxonomy, Blackie Academic & Professional, London: 331 pp.
4. Schuh, R. T. and Brower, A. V. Z. 2009. Biological Systematics: Principles and Applications (2ndedn.). Cornell University Press: 311 pp.
5. Venkataraman K & C. Sivaperuman. 2014. Marine Faunal Diversity in India: Taxonomy,Ecology and Conservation. Academic Press 546 pp.

Course: Practical **Course Code: UAQC 111 (P)**

Title: TAXONOMY and FISHING TECHNOLOGY

Hrs / Week:2 **No. of Credits:1**

1. Identification of fishes up to species level- 20 nos. from different families
2. Identification of prawns of commercial importance
3. Identification of commercially important molluscans
4. Identification of traditional fishing gears
5. Different types of hooks
6. Identification of fishing accessories
7. Identification of synthetic and natural fibers
8. Artificial and live baits
9. Identification of modern gears
10. Fish detection devices - On board visit.

Course: DSC-2A **Course Code : UAQC 112**

Title: BASIC PRINCIPLES OF AQUACULTURE

Hrs/Week: 4 **No. of Credits:4**

Unit I

Scope and definition; origins and growth of aquaculture; biological and technological basis; Traditional, extensive, semi - intensive and intensive culture; monoculture, polyculture, composite culture, mixed culture, monosex culture; cage culture, pen culture, raft culture, race way culture, culture in recirculatory systems; warm water and cold-water aquaculture; sewage – fed fish culture, integrated fish farming.

Unit II

Survey and location of suitable site – topography; soil characteristics; acid sulphate soils; water source; hydro-meteorological data.– precipitation, direct run off, stream inflow, ground water inflow, regulated inflow; water loss – evaporation, seepage, outflow, consumptive use, water budgets of embankment ponds; water budget of an excavated pond; water exchange

Unit III

Types of ponds – design, layout, construction, water intake system, drainage system; aeration and aerators; sun drying, ploughing / tilling, desilting, liming and fertilization, eradication of weed fishes. Recent advances in aquaculture engineering; tips for better aquaculture practices; design and construction of hatcheries.;

Unit IV

Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation. Acclimatization of seed and release; species combinations; stocking density; ratio

Unit V

Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms; specific food consumption, food conversion ratio (FCR), protein efficiency ratio, true net protein utilization, apparent net protein utilization, biological value of protein

Unit VI

Measurement of growth; length - weight relationship; methods of determination of age in fishes and shellfish based on length data and growth checks; ponderal index; growth hormones.

Text books and References

1. Mathew Landau. 1995. Introduction to Aquaculture. Daya Publishing House, New Delhi.
2. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications.
3. MPEDA, 1991. Hand Book on Shrimp Farming, Kochi, India.
4. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
5. Chakrabarti, N. M. 1998. Biology, Culture and Production of Indian Major Carps. Narendra Publishing House, New Delhi.
6. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. Daya Publishing House, New Delhi.
7. Upadhyay, A. S. 1995. A Hand Book on Design, Construction and Equipment's in Coastal Aquaculture (Shrimp Farming). Daya Publishing House, New Delhi.

Course: Practical **Course Code : UAQC 112 (P)**

Title: FIELD VISIT AND SPECIMEN COLLECTION

Hrs/Week:2 **No. of Credits: 1**

Collection:

1. Cultivable fin fishes/ crustaceans/ molluscs
2. Weed fishes/ predatory fishes
3. Aquatic insects from aquaculture ponds
4. Collection and identification of cultivable fishes and prawns

Field visit:

1. Visit to coastal aquaculture farms
2. Visit to a shrimp hatchery
3. Visit to an ornamental fish farm/ aquarium

Course: DSC-3A **Course Code : UAQC 113**

Title: **INVERTEBRATE ZOOLOGY**

Hrs/Week:4 **No. of Credits:4**

Unit I:

Principles of Taxonomy – Binomial nomenclature – Rules of nomenclature – Whittaker's five kingdom concept and classification of Animal Kingdom. **Protozoa:** General characters and classification up to classes with suitable examples of Indian context. Type study – *Paramecium.*

Unit II:

Porifera: General characters and classification up to classes with suitable examples of Indian context. Type study – *Leucosolenia.* **Coelenterates**: General characters and classification up to classes with suitable examples of Indian context. Type study – *Obelia.* **Ctenophora**: Classification, Salient features with suitable examples of Indian context.

Unit III:

Platyhelminthes: General characters and classification up to classes with suitable examples of Indian context. Type Study: *Taenia solium.* **Aschelminthes**: General characters and classification up to classes with suitable examples of Indian context. Type study: *Ascaris lumbricoidus*

Unit IV:

Annelida: General characteristics and Classification up to classes (Ruppert and Barnes, 1994). Excretion in Annelida through nephridia; Metamerism in Annelida. **Arthropoda**: General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Insect Eye (Cockroach only). Respiration in Prawn and Cockroach; Metamorphosis in Lepidopteran Insects; Social life in Termite. Type study; *Penaeus monodon.*

Unit V

Onychophora: General characteristics and Evolutionary significance. **Mollusca**: General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Nervous system in *Pila sp*. Torsion in Gastropoda. Feeding and respiration in *Pila* sp.

Unit VI

Echinodermata: General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water vascular system in *Asterias*. Echinoderm larva and affinities with chordates. General characteristics of phylum Hemichordates. Relationship with non-chordates and chordates

Text books and References

1. Kotpal, R. L.,2000, Modern Text Book of Zoology –Invertebrates, 8th Revised eedition (Reprint), Rastogi Publications, Meerut – 250 002.
2. Ayyar, E.K. and T.N. Anandakrishnan, 1992.Manual of Zoology Vol. 1 (Invertebrate), Part I & II. S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 991p.
3. Jordan, E.L. and P.S. Verma, 2010, Invertebrate Zoology, S. Chand & Co Ltd., Ram Nagar, New Delhi.
4. Barnes R.D (1992) Invertebrate Zoology IV Edn. Holt Saunders International Edn
5. Jordan, E.L. and P.S. Verma, 2022, Invertebrate Zoology, S. Chand & Co Ltd., Ram Nagar, New Delhi. 1156p

Course: Practical **Course Code : UAQC 113 (P)**

Title: INVERTEBRATE ZOOLOGY

Hrs/Week:2 **No. of Credits:1**

I. DISSECTION

A. Prawn:

1. Digestive system

2. Nervous system

B. Cockroach

3. Digestive system

4. Nervous system

II. MOUNTING

7. Mollusc- radula

8. Mouth parts of Mosquito

9. Sting apparatus of Honey bee

10. Prawn appendages

III – SPOTTERS (any 30 spotters)

A- Classify giving reasons up to order:

1. Paramecium

2. Scypha

3. Aurelia

4. Fasciola

5. Ascaris

6. Neanthes

7. Penaeus

8. Lamellidens

9. Asterias

B- Draw labeled sketches:

10. L.S. Sponge

11. Obelia medusa

12. Physalia

13. Ephyra larva

14. Redia larva

15. Cercaria larva

16. Mysis larva

17. Alima larva

18. Bipinnaria larva

C- Comment on Biological significance:

19. Entamoeba

20. Paramecium – Conjugation

21. Plasmodium

22. Obelia colony

23. Velella

24. Fasciola – Miracidium

25. Taenia – Mature proglottid

26. Ascaris

27. Heteronereis

28. Trochophore larva

29. Chaetopterus

30. Peripatus

31. Hirudinaria

32. Limulus

33. Nauplius larva

34. Zoea larva

35. Chiton

36. Sepia

37. Octopus

38. Sacculina on crab

39. Sea anemone on Hermit crab

D – Relate structure and function:

40. Sponge – Spicules

41. Sponge – Gemmule

42. Taenia – Scolex

43. *Neanthes* – Parapodium
44. Earth worm – Penial setae
45. *Penaeus* – Petasma
46. Honey bee – Sting apparatus
47. Scorpion – Book – lungs
48. Starfish – Pedicellaria
49. Starfish - Tube foot.

Course: DSC-1B **Course Code : UAQC 121**

Title: BREEDING AND REARING OF AQUARIUM FISHES.

Hrs/Week:4 **No. of Credits:4**

Unit I

Introduction to aquarium, ornamental fishes and aquarium accessories. World aquarium trade and present status. Types of aquaria. Oceanarium. Design and construction of a beginner's aquarium. Water quality requirements and management.

Unit II

Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes. Cleaning the aquarium; maintenance of water quality. Control of snail and algal growth. Handling, care and transportation of fish. Temperature acclimation, oxygen packing.

Unit III

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. Larval rearing. Important freshwater plants – their taxonomy and morphology, multiplication of aquarium plants – different methods.

Unit IV

Commercial production of goldfish, live bearers, gourami's, barbs and tetras, angel fish. Mass production of aquarium plants. Indigenous ornamental fishes of Kerala (major species, distribution, significance and threats). Seed production of Miss Kerala.

Unit V

Marine ornamental fishes – Major marine ornamental fish resources of India. Breeding of marine ornamental fishes. Setting of marine aquariums. Reef aquarium and live rocks. Other ornamental organisms – anemones, worms, lobsters, shrimps, octopus, starfish.

Unit VI

Nutritional requirements of aquarium fishes. Different kinds of feeds. Culture of fish food organisms; Feeding methods. Use of pigments for colour enhancement. Identification of common parasites infecting ornamental fishes. Study of bacterial, viral, fungal diseases of ornamental fishes and their control and prophylaxis (brief account only).

Text books and References

1. Biswas. S.P., J. N. Das, U. K. Sarkar and Lakra W.S. 2007 Ornamental fishes of NorthEast India: An Atlas: NBFGR
2. Marine Aquarium keeping: The Sciences, Animals and Art. John Wiley & Sons, New York
3. Ramachandran. A, Breeding, Farming and Management of Fishes, CUSAT
4. Madhusudan Kurupetal– Ornamental Fish - Breeding, Farming and Trade CUSAT.
5. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
6. Santhanam, R. and A. Srinivasan. 1994. A Manual of Marine Zooplankton. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Course: Practical **Course Code : UAQC 121 (P)**

Title: BREEDING AND REARING OF AQUARIUM FISHES.

Hrs/Week:4 **No. of Credits:4**

1. Identification of common aquarium fishes
2. Indigenous ornamental fishes of Kerala
3. Setting up of aquarium
4. Aquarium plants
5. Working of air pump and biological filter and other accessories.
6. Breeding of live breeding fish
7. Breeding of egg layers- gold fishes
8. Breeding of bubble nest builder- Gourami
9. Control of snails in ornamental fish culture system
10. Marine aquarium fishes and invertebrates
11. Disease of aquarium fishes (signs and causative agents and treatments)
12. Water quality management in aquariums
13. Construction of aquarium

Course: DSC-2B **Course Code: UAQC 122**

Title: ECOLOGY OF AQUATIC ENVIRONS

Hrs/Week:4 **No. of Credits:4**

Unit I

Definition of ecology, organism and environment; features of organism - environment relations; living and non - living environments; the ecosystem or habitat. Freshwater ecosystems - Lotic and Lentic ecosystems; Marine ecosystems - oceans and seas, zonation of the seas - rocky, sandy and muddy shores; classification of marine habitat - pelagic, benthic, neritic, oceanic, littoral and abyssal.

Unit II

Physical characteristics of water: Light - penetration of sunlight into aquatic media, effect of light on productivity, photoperiodicity in animals; Temperature - annual temperature cycles, thermal stratification of water bodies, thermal optimum, maximum and minimum, water movements, periodic and a periodic current system; Turbidity - causes, variations and effects.

Unit III

Chemical characteristics of water: Atmosphere and atmospheric gases dissolved in water; Oxygen - oxygen and life, hypoxia, anoxia and hyperoxia, adaptations of animals to varying oxygen tensions; Carbon dioxide - sources of Co2, its ecological effects; pH or hydrogen ion concentration - its significance. total hardness and total alkalinity

Unit IV

Biogeochemical cycles: Nitrogen cycle; phosphorus cycle; sulfur cycle; carbon cycle; trace elements - manganese and copper. Organic matter: Aquatic vegetation – zones of aquatic vegetation; Plankton - classification of plankton, factors affecting plankton distribution, plankton counting and sampling; phytoplankton - zooplankton relationship, plankton productivity; Benthos - phytobenthos and zoo benthos.

Unit V

Productivity: Concept of productivity – standing crop, rate of production and rate of removal; primary and secondary productivity; classification of water bodies on thebasis of productivity.

Unit VI

Dynamics of aquatic ecosystem: Principal steps and components – niches, trophic levels and relations; producers, consumers, decomposers and transformers; food chain and food web; pyramid of biomasses; pyramid of numbers; energy transfer in the ecosystem.

Text books and References

1. Pillai, N. K. 1993. Marine Biology and Ecology. Daya Publishing House, New Delhi.
2. Reid, G. K. and R. D. Wood. 1976. Ecology of Inland Waters and Estuaries D. Van Nostrand Company.
3. Kormondy, E. J. 1996. Concepts of Ecology. Prentice Hall of India Pvt. Ltd. New Delhi.
4. Cole, G. L. 1954. Text Book of Limnology. The C. V. Mosloy Co.,
5. Odum, E. P. 1996. Fundamentals of Ecology.3rd End. Natraj Publishers, Dehradun.
6. Santhanam, R. and A. Srinivasan. 1994. A Manual of Marine Zooplankton. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Pillai, N. K. 1986. Introduction to Planktanology. Himalaya Publishing House, Mumbai.
8. Balakrishnan Nair, N and D. M. Thampy. 1980. A Text Book of Marine Ecology. McMillan India Ltd.

Course: Practical **Course Code : UAQC 122 (P)**

Title: Water Quality Parameters

Hrs/Week:4 **No. of Credits:4**

1. Determination of salinity by refractometer and titrimetric method.
2. Determination of water pH
3. Determination of alkalinity
4. Determination of hardness of water
5. Determination of dissolved oxygen
6. Determination of organic carbon in pond soil
7. Determination of nitrite / nitrate - demonstration
8. Determination of phosphate in pond water - demonstration
9. Determination of soil pH
10. Calculation of lime requirement
11. Testing of potential acid sulphate soil
12. Determination of Secchi disc transparency of water

Course: DSC-2B **Course Code: UAQC 123**

Title: **VERTEBRATE ZOOLOGY**

Hrs/Week:4 **No. of Credits:4**

Unit I

General characteristics and outline classification of Phylum Chordata (Young, 1981). Protochordata: General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes (Young, 1981). Metamorphosis in *Ascidia*. Chordate Features, structure of pharynx and feeding in *Branchiostoma*

Unit II

Agnatha: General characteristics and classification of cyclostomes up to order (Young, 1981). Pisces: General characteristics and classification up to living sub classes (Young, 1981); Accessory respiratory organ, Migration in fishes; Parental care in fishes; Swim bladder in fishes.

Unit III

General characteristics and classification up to living Orders (Young, 1981); Metamorphosis, Paedomorphosis, Parental care in Amphibia

Unit IV

Reptilia: General characteristics and classification up to living Orders (Young, 1981); Poison apparatus and Biting mechanism in Snake. Poisonous & Non-Poisonous snake.

Unit V

Aves: General characteristics and classification up to living Sub-Classes (Young, 1981); Exoskeleton and migration in Birds; Principles and aerodynamics of flight.

Unit VI

General characters and classification up to living sub classes (Young, 1981); Exoskeleton derivatives of mammals; Adaptive radiation in mammals with reference to locomotory appendages; Echolocation in Micro chiropterans.

Text books and References

1. Jordan EL, Verma PS. 2003.Chordate Zoology. S. Chand & Company Ltd. New Delhi.
2. Kent GC, Carr RK. 2001.Comparative anatomy of the Vertebrates. 9th Ed. Mc Graw Hill.48
3. Pough H, Christine MJ, Haiser B. 2002. Vertebrate life, VIII Edition, Pearson.
4. Romer AS, Parsons TS. 1986. The vertebrate body. 6th Ed. Saunders College Publishing
5. Sinha K S, Adhikari S, Ganguly BB. 2001. Biology of Animals. Vol. II. NCBA
6. Young J Z. 2004. The Life of Vertebrates. III Edition. Oxford University press

Course: Practical **Course Code: UAQC 123 (P)**
Title: **VERTEBRATE ZOOLOGY**
Hrs/Week:4 **No. of Credits:4**

DISSECTION

Fish: Digestive, Nervous system, Male and female Reproductive system

I. MOUNTING

1. Placoid scales.

2. Ctenoid scales.

3. Cosmoid scales

III – SPOTTERS (any 30 spotters)

A- Classify giving reasons up to order:

1. Balanoglossus

2. Herdmania (=Ascidian)

3. Branchiostoma (= *Amphioxus*)

4. Petromyzon

5. Scoliodon sorrakowah

6. Mugil oeur

7. Rana hexadactyla

8. Calotes versicolor

9. Columba livia

10. Oryctolagusc cuniculus

B - Draw labeled sketches:

11. Amphioxus – T.S. through pharynx.

12. Doliolum

13. Salpa

*14. Arboresant organ of cat fish*es

15. Accessory respiratory organ of Anabas

16. Flight muscle of Birds

17. Poisonous apparatus of Snake

18. Narcine

19. Naja naja

20. Typhlops

C- Comment on Biological significance:

21. Tornaria larva

22. Ascidian Tadpole larva

23. Anabas scandens

24. Hippocampus

25. Echeneis

26. Rhacophorus

27. Ichthyophis

28. Amblystoma

29. Axolotle larva

30. Chamaeleon

31. Vipera russelli (= Russel's viper)

32. Draco volans

33. Bat

D –Relate structure and function:

34. Fish - air bladder

35. Fang of Snake

36. Placoid- Scale of Shark.

37. Filter feeding structure of Whale- Baleen plates

38. Quill Feather of pigeon

39. Aquatic mammals- limbs

40. Contour feather

Course: DSC-1C **Course Code: UAQC 231**

Title: AQUACULTURE OF FRESHWATER FISHES

Hrs/Week:4 **No. of Credits:4**

Unit I

Scope and significance of aquaculture, comparison of aquaculture with capture fisheries. Different aquaculture systems. Global and Indian Scenario of Aquaculture. Criteria for the selection of species, common species cultured. Freshwater cultivable fishes.

Unit II

General concepts of ecology, productivity, carrying capacity, food chain and food web. Ecology of culture ponds. Nutrient cycles -- Nitrogen , Phosphorous and Carbon cycles. Laws of limiting factor. Nutrient dynamics. Significance and important groups of phytoplankton, zoo plankton and benthos in culture ponds. algal blooms.

Unit III

Selection of site, types of ponds, nursery rearing, stocking ponds, preparation of ponds- liming, Different methods for the eradication of weed fishes, predators, aquatic insects and aquatic weeds, fertilization and manuring, , stocking and post stocking management, harvesting. Management of water and soil quality parameters.

Unit IV

Cultivable species of freshwater prawns and their biology -culture of M*acrobrachium rosenbergii*, Culture of cray fish. Important freshwater molluscs-Biology and culture of *Lamellidens marginalis*. Freshwater pearl culture -Present status of freshwater pearl culture and production in India. Culture of air breathing fishes. Culture of cold water fishes in India. Sewage fed fish culture, sewage treatment-Sewage cum fish culture in India. Fish in relation to public health - Larvivorous fishes and mosquito eradication using fishes.

Unit V

Recent development in integrated farming -Rice cum fish culture, Duck cum fish culture, Poultry cum fish culture and Pig cum fish culture. Organic aqua farming. Aquaponics, Integrated Multitrophic Aquaculture (IMTA). Biofloc based aquaculture practices – C:N ratio-Fish culture in cages and pens. Running water fish culture. Culture of exotic species

Unit VI

Organizations involved in freshwater aquaculture research and development - CIFA, NBFGR, NACA, SEAFDEC, ADAK, FFDA

Text books and References

1. Santhanam R., N. Sukumaran, P. Natarajan 1987. A Manual of Freshwater Aquaculture, South Asia Books
2. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications
3. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
4. Pillai, N. K. 1993. Marine Biology and Ecology. Daya Publishing House, New Delhi.

Course: Practical **Course Code: UAQC 231 (P)**

Title: **FARM MANAGEMENT**

Hrs/Week:2 **No. of Credits:1**

1. Identification of cultivable aquatic organisms
2. Identification of common weed and predatory fishes
3. Collection and identification of phyto and zooplankters (in aquaculture ponds)
4. Identification of different larval stages of penaeid and palaemonids shrimp
5. Identification and working of various equipment's in farm and hatchery
6. Eradication of aquatic weeds, insects and predatory fishes from aquaculture pond.
6. Identification of different live feed organisms
7. Enumeration of micro algae using hemocytometer
8. Trials of decapsulation and hatching of artemia
9. Calculation of feed requirement
10. Feed formulation techniques
11. Preparation of artificial feed for aqua cultured organism

Course: DSC-2C **Course Code: UAQC 232**

Title: **BIOLOGY OF FISHES**

Hrs/Week:4 **No. of Credits:4**

Unit I

General characters of fishes, adaptations for swimming, body forms, fins. Structure and function of skin and mucous layer. Different types of scales and its modifications. coloration in fishes. Bioluminescence in fishes. Sense organs in fishes –organs of smell, taste buds, lateral line system. Ampullae of Lorenzini etc. Specialized organs in fishes – electric organs and toxins in fishes.

Unit II

Food and feeding habits -herbivores, carnivores and omnivores. Feeding adaptations methods, employed in the study of gut content analysis- volumetric, gravimetric etc. Feeding indices- GSI. Age andgrowth -Techniques used in the study -use of scales and otoliths, length frequency analysis- VBGF, equations used for deriving growth rates

Unit III

Reproduction –ovary and testes, structure, development of primary and secondary sexual characteristics. Sexual dimorphism in fishes. Maturation and spawning in fishes, factors affecting maturation and spawning. Fecundity, condition factor, size at first maturity. Oviparous, viviparous and ovoviviparous fishes. Parental care and breeding migration in fishes. Migration in fishes –anadromous and catadromous, homing, instinct and orientation.

Unit IV

Digestive system -General morphological features of digestive system in fishes. Respiratory system -general description, aquatic respiration, respiratory gases, gaseous exchange, oxygen transport. Adaptations for air breathing in fishes. Cardiovascular system -General features of heart and blood circulation, circulatory system and oxygen transport in fishes.

Unit V

Endocrine organs in fishes. Hormones and their role in control of reproduction in fishes. Endocrine system in crustacean and molluscs. Role of hormones in reproduction and molting in crustacean. Excretion and osmoregulation. Nitrogenous excretion freshwater and marine fishes. Water and salt balance.

Unit VI

Principles of zoological classifications, binomial nomenclature of commercially important fishes, crustaceans and molluscs.

Text books and References

1. Moyle,P. B. and Cech. Fishes 2003 – An Introduction to Ichthyology
2. Norman. 2020 A History of Fishes.
3. Nicholski, G.V 2008. Ecology of Fishes.
4. Lagler. 1991, Ichthyology. John Wiley & Sons
5. Francis Day. Fishes of India.
6. Munro,I. S. R. 2000, The Marine and Freshwater Fishes of Ceylon.

Course: Practical **Course Code: UAQC 232 (P)**

Title: **BIOLOGY OF FISHES**

Hrs/Week:2 **No. of Credits:1**

1. Morphometric measurements of fishes
2. Fin forms of fishes and swimming behaviour
3. Types of scales, placoid, cycloid & ctenoid
4. Examination of structure of gill and assessment of feeding behaviour–*Sardinella*/ *Channa* sp.
5. Mounting of appendages of Prawn
6. Dissect and display of alimentary canal of fishes/prawns
7. Fecundity estimation in fishes/ prawn and its relationship with length and weight
8. Gut content analysis: - Volumetric methods

Course: DSC-2C **Course Code : UAQC 233**

Title: **EVOLUTION AND CONSERVATION BIOLOGY**

Hrs/Week:4 **No. of Credits:4**

Unit-I

Origin of Life on Earth, Evidences of Evolution – Morphological, Embryological, and paleontological. Geological time scale – Fossils & Fossilization, Dating of Fossil Living, connecting and Extinct Fossils.

Unit –II

Theories of Evolution: Lamarckism, Neo-lamarckism, Darwinism, Neo-Darwinism, Devries concept of Mutation, Modern version of Mutation theory.

Unit –III

Origin of Species, Phylogenetic and biological concept of species: Mechanisms of reproductive isolation; Models of speciation Hardy –Weinberg law of genetic equilibrium. natural selection, mutation, genetic drift and migration.

Unit –IV

Concepts of conservation: prospective and expression of biodiversity concepts, Scope-Regional and National approaches for biodiversity conservation, Conservation of terrestrial and aquatic resources. Human impact on terrestrial and aquatic resources, Information on CITES, IUCN, CBD and RDB. Concepts of threatened fauna of India. IUCN categories, wildlife conservation approaches and limitations, Project tiger.

Unit – V

Threats to biodiversity: Habitat loss; invasive species, Overexploitation, Climatic changes. Anthropogenic activities: Pollution. Biodiversity management: Ex-situ and In-situ conservation. Protected areas- Wild life wealth of India, Hot spots, Restoration of damaged ecosystem and endangered population

Text books and References

1. Dobzhansky, T., F. Jayala, G. L. Stebbins and J. M. Valentine 1998. Evolution, Surjeet Publications, New Delhi.
2. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. Science Publication.
3. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.
4. Rangarajan M. (2001) India's Wildlife History. Permanent Black, New Delhi, India.

Course: Practical **Course Code: UAQC 233 (P)**

Title: EVOLUTION AND CONSERVATION BIOLOGY

Hrs/Week:2 **No. of Credits:1**

1. Study of Fossils
2. Field Visit to wild life sanctuaries and National parks (Tour report submission)
3. Homologous organs
4. Analogous organs
5. Industrial melanism
6. Adaptive radiation (Darwin finches)
7. Living fossils
8. Connecting link
9. Hardy Weinberg law calculation

Course: DSC-1D **Course code: UAQC 241**

Title: **MARICULTURE**

Hrs/week:4 **No. of Credit:4**

Unit I

Introduction and present status of brackish water farming in India. Brackish water as a medium for aquaculture - ecological factors – abiotic and biotic factors. Selection of site. Traditional practices in India – paddy field prawn filtration in Kerala and Bhasabadha fisheries in West Bengal.

Unit II

Selection of cultivable species in brackish water systems, their biology and culture practices– monoculture and polyculture of – *Chanos chanos, Mugil cephalus, Etroplus suratensis, Oreochromis mossambicus*. Culture of carnivorous fishes – *Lates calcarifer.* Nursery, rearing and grow out in ponds, cages and pens. Sea ranching

Unit III

Species of shrimps cultured in brackish water and their biology – *Penaeus monodon, Feneropenaeus indicus* and *Penaeus vannamei*. Systems of shrimp farming. Species of crabs cultured and their biology, crab culture techniques, prospects in India. Culture of lobsters– experimental culture and prospects in India.

Unit IV

Various ecological subdivisions of the sea. Different designs of open sea farming structures– construction of cages – bioengineering problems and solutions – scope of open sea farming in India. Important fin fishes cultured in the open seas.

Unit V

Molluscan culture – species of edible oysters, mussels and clams cultured, culture techniques used for farming edible oysters and mussels. Important species of pearl oysters and method of artificial pearl production. Culture of seaweeds, common cultivated species, culture techniques and harvesting. Present status and recent developments in mariculture.

Unit VI

Environmental impact of brackish water and coastal aquaculture- effluent discharge, eutrophication, chemical residues including antibiotics, destruction of natural habitat including paddy field and mangroves. Salinity intrusion. Coastal zone management and CRZ. Regulation of coastal aquaculture and Coastal Aquaculture authority of India. Introduction of exotics, genetic erosion of indigenous stock.

Text books and References

1. Pillai, N. K. 1993. Marine Biology and Ecology. Daya Publishing House, New Delhi.
2. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications
3. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
4. Milne P H. 1979 – Fish and Shell fish farming in coastal waters
5. Kurian, C.V and Sebastian V.O. – Prawn and Prawn fisheries of India

Course: Practical **Course code : UAQC 241 (P)**
Title: Life feed, Culture, Stock culture maintenance
Hrs/week:2 **No. of Credits: 1**

1. Water quality analysis using various equipment's.
2. Estimation of primary productivity
3. Estimation of Ammonia and BOD in farm water
4. Preparation of pelleted aquafeed
5. Collection and biochemical evaluation of locally available feed ingredients
6. Assessment of growth of fish in culture system and FCR.
7. Aquarium keeping- setting up of home aquarium.
8. Induced breeding in fishes-Demonstration
9. Breeding and rearing of common ornamental fishes
10. Culture of live feed

Course: DSC-2D **Course code : UAQC 242**
Title: SEAFOOD PROCESSING TECHNOLOGY
Hrs/week:4 **No. of Credits:4**

Unit I

Fish as raw material for processing. Handling of fish onboard fishing vessels. Structural and chemical changes associated with postmortem. Factors affecting quality of fresh fish. Chill storage of fish. Discoloration in aquatic products, Depuration of bivalves. Live fish/shell fish Transportation to local markets and processing centers.

Unit II

General Principles of food preservation. High temperature, low temperature, drying, radiation and chemicals. Microbial growth in food: intrinsic and extrinsic parameters and means of control (food formulations, cooking, preservatives, pH.aW)

Unit III

Simple mechanical refrigeration systems. Ice plants, chilling, supper chilling, refrigerated and chilled seawater.

Unit IV

Freezing, slow freezing, quick freezing, types of freezers, freezing time, freezing of fish and shell fish. Technological aspects of freezing: Methods of freezing, comparison of various freezing

Unit V

Preparation of salted fishes, dried fish and smoked fish. Accelerated freeze drying. Canning: Principles of thermal processing Mechanism of heat transfer, canning in oil and brine. Filleting, breading etc. utilization of fishery wastes such as prawn shell, fish offal, fish meal, chitin, chitosan. Fish silage.

Text Books & References:

1. Desrosier N.W. 2012 Fundamentals of Food Freezing
2. Brody J. Fishery Byproduct Technology
3. Chichester C.O. 2013. Microbial Safety of fishery Products, Academic Press.
4. Anthony T. Tu 1983. Handbook of Natural toxins.
5. Gopakumar K. Text Book of Fish Processing Technology.
6. Huss, H. H. et al. Quality assurance in the fish industry.
7. John, D. E. V. 1997. Food safety and toxicity, CRC Press.

Course: Practical **Course code: UAQC 242 (P)**
Title: SEA FOOD PROCESSING TECHNOLOGY
Hrs/week:2 **No. of Credits:1**

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

Course: DSC-3D **Course code: UAQC 243**
Title: GENETICS & MOLECULAR BIOLOGY TECHNIQUES
Hrs/week:4 **No. of Credits:4**

Unit 1: Fundamentals of cell Biology
Structure of cell: prokaryotic and eukaryotic cell. Subcellular organelles and nucleus, chromosomes, mitochondria, chloroplast, ribosomes, endoplasmic reticulum, golgi complex, lysosomes, microfilaments, microtubules and intermediate filaments, glyoxysomes and peroxysomes (Brief description only). Cell division - Mitosis and meiosis

Unit 2: DNA World

Nucleic acids, Structure of DNA and RNA, DNA replication, translation and transcription, genetic code.

Unit 3: Basic Genetics
Introduction- Genetics, Mendel's law of inheritance. Gene interactions. Chromosome structure and types. Dominance relationships -complete, incomplete and co-dominance, multiple alleles, linkage. Chromosomal aberrations: Monosomy, trisomy. Mutations and mutagens. Translocations, inversions, duplications, deletions.

Unit 4: Selection and Hybridization

Genetic selection- types of selection and significance. Principles of breeding- selective hybridisation, intra-specific and inter-specific hybridisation. Hybrid vigor, and inbreeding depression. Practical application of genetics in aquaculture. Sex determination in fishes.

Unit 5: Aquaculture Biotechnology
Recombinant DNA technology, determinants of DNA replication, cloning, vectors, transformation, DNA hybridisation. Tissue culture. PCR. Use of PCR for the detection of white spot syndrome in shrimp. Biotechnological tools for aquaculture, gene manipulation in fish, transgenic fish production. Chromosome manipulation in fish and shell fishes triploidy, polyploidy, gynogenesis, androgenesis. Monosex production, super male and super female fish production techniques. Synthetic hormone production for induced breeding. Cryopreservation.

Unit 6: Marine Biotechnology
Scope of marine biotechnology, general application of molecular biological techniques to the marine sciences. Marine toxins. Industrial chemicals and pharmaceuticals from marine sources. Tissue culture in sea weed and pearl production.

Course: Practical **Course code: UAQC 243 (P)**
Title: GENETICS & MOLECULAR TECHNIQUES
Hrs/week:2 **No. of Credits:1**

1. Enumeration of total RBC and WBC of fish
2. Estimation of hemoglobin content in fish
3. Barr bodies
4. Chromosomal aberrations (spotters)
5. Isolation of genomic DNA
6. Separation of DNA by Agarose gel Electrophoresis
7. Northern Blotting technique (Demonstration)
8. Southern Blotting technique (Demonstration)

SKILL ENHANCEMENT COURSES
(COMPULSORY)

Course: SEC – 1 **Course code: UAQC 234**

Title: POND PREPARTION AND MANAGEMNT

Hrs/week:2 **No. of Credits:2**

UNIT I

Pisciculture – definition, scope and importance- major cultured freshwater fishes in India and world

UNIT II

Production and trade, global scenario, current scenario of pisciculture in India

UNIT-III

Types of fish ponds- Classification of ponds based on water resources – spring, rain water, flood water, well water and water course ponds - Functional classification of ponds – head pond, hatchery, nursery, rearing, production, stocking and quarantine ponds

UNIT- IV

Pond preparation - Important factors in the construction of an ideal fish pond – site selection, topography, nature of the soil, water resources

Unit V

Lay out and arrangements of ponds in a fish farm - Construction of an ideal fish pond – space allocation, structure and components of barrage pond.

UNIT-VI

Pond management factors - Need of fertilizer and manure application in culture ponds; Role of nutrients; NPK contents of different fertilizers and manures used in aquaculture; and precautions in their application -Physico-chemical conditions of soil and water optimum for culture –Eradication of predators and weed control – advantages and disadvantages of weed, weed plants in culture ponds, aquatic weeds, weed fish, toxins used for weed control and control of predators.

Text Books & References:

1. Jhingran VG 1998. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi

2. Pillay TVR, 1996. Aquaculture Principles and Practices, Fishing News Books Ltd., London

3. Pillay TVR & M. A. Dill, 1979. Advances in Aquaculture. Fishing News Books Ltd., London

4. Boyd CE 1982. Water Quality Management for Pond Fish Culture. Elsevier ScientificPublishing

Course: SEC – 2 **Course code: UAQC 244**

Title: SEMINAR, EXHIBITION, SETTTING AQUARIA

Hrs/week:2 **No. of Credits**:**2**

Identifying suitable topic in Aquaculture and Fisheries. Preparation of report for the seminar presentation and Presentation of the seminar in PPT format. Discussion on the topic and evaluation.

Conduct exhibition related to the field of interest.

Course: SEC – 3 **Course code: UAQC 351**

Title: VALUE ADDED FISHERY PRODUCTS

Hrs/week:2 **No. of Credits:2**

UNIT I

Value addition in sea food. Different types of value-added products from fish and shell fish. Advantages of value addition. Significance of value addition in the seafood industry.

UNIT II

Fish mince and Surimi. Production of fish mince – merits and demerits. Analogs and fabricated products. Quality assessment of surimi. Equipment and raw material for surimi, role of cryo protectants in surimi production

UNIT III

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

UNIT IV

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

Text Books & References:

1. Govindan T.K 1997. Fish Processing Technology, Oxford IBH–

2. Balachandran, K.K-2002. Post Harvest Technology of Fish and Fish Products.

3. Venugopal V.2005, Seafood Processing, CRC Press.

4. Hall G.M2008. Fish Processing Technology –Chapman & Hall, Madras

Course: SEC – 3 **Course code: UAQC 352**

Title: BIOFUEL TECHNOLOGY/SEAWEED CULTURE

Hrs/week:2 **No. of Credits:2**

UNIT I

Renewable and non-renewable resources, important renewable resources from the ocean.

Biofuels-ethanol and biodiesel.

UNIT II

Biofuel types- different sources of biofuels from the sea

UNIT III

Different technology used for the extraction of biofuels – from algal and animal biomass

UNIT IV

Seaweeds- morphology and uses. Biofuel extraction from seaweeds and microalgae.

UNIT V

Importance of biofuel –current status of biofuel production in the world. Economics of biofuels.

Text Books & References:

1. David M. Mousdale.2010. Introduction to biofuels. Taylor & Francis.
2. Carlos Ricardo Soccol et.al 2016. Green Fuels Technology. Biofuels (Green Energy and Technology. Springer
3. Mostafa El-Sheekh, Abd El-Fatah Abomohra. 2021. Handbook of algal biofuels. Elsevier

Course: SEC – 4 **Course code: UAQC 361**

Title: **BIOINFORMATICS**

Hrs/week:2 **No. of Credits:2**

UNIT-I (5 hours)

Bioinformatics: an overview - Introduction to Computational Biology and Bioinformatics; Role of internet and www in bioinformatics, Scope and relevance.

UNIT – II

Biological Databases: Acquisition –Primary and Secondary databases. Types of Biological data bases – (Nucleotide, protein, organism and biodiversity databases) – examples and uses of each category of data bases.

UNIT-III

Nucleotide sequence databases: Types of DNA sequences – genomic DNA, cDNA, recombinant DNA, Expressed sequence tags (ESTs), Genomic survey sequences (GSSs); RNA sequencing methods. Database searching (BLAST and FASTA).

UNIT – IV

Genomics and Proteomics – definition & Scope, Fisheries databases and websites: FISHBASE, NACA, ICLARM, FAO.

UNIT-V

Phylogenetic analysis –Phylogenetic representations – graphs, trees and cladograms; Steps in phylogenetic analysis; Neighbor Joining Method; Fitch/Margoliash method; Phylogenetic software –PHYLIP

UNIT-VI (5 hours)

Applications of bioinformatics in Drug discovery: Structure based drug design. Mining of sequence data: Mining data from marine sponges.

Text books & References

1. Mount, D. Bioinformatics: Sequence and Genome Analysis; Cold Spring Harbor Laboratory Press, New York. 2004

2. Lesk, A.M. Introduction to Bioinformatics, First edition, Oxford University Press, UK.2002

3. Rastogi, S.C, Mendiratta. N and Rastogi. R. Bioinformatics: Concepts, Skills and Applications, CBS Publishers, New Delhi, India. 2006

4. Pevzner, P.A. Computational Molecular Biology; Prentice Hall of India Ltd, New Delhi.2004

5. Sensen, C.W. Essentials of Genomics and Bioinformatics. Wiley-VCH Publishers, USA. 2002

6. Andrew R. Leach Molecular Modeling – Principles and Applications Second Edition,Prentice Hall, USA. 2001

Course: SEC – 4 **Course code : UAQC 362**

Title: HERBARIUM PREPARATION OF MARINE PLANTS

Hrs/week:2 **No. of Credits:2**

Collection and identification of different marine plants (seaweeds, seagrasses and mangroves).

Preparation of herbarium of the collected samples.

DISCIPLINE SPECIFIC ELECTIVES

Course: DSE 1A **Course code: UAQC 353**

Title: AQUACULTURE ENGINEERING

Hrs/week:6 **No. of Credits:4**

UNIT 1: Farm Engineering.

Criteria for the selection of site for aquaculture - Surveying – chain survey, plane table survey, leveling. Calculation of earthwork for the construction of ponds. Types of soil, soil sampling methods, prevention of erosion.

UNIT 2: Farm Design and Equipment

Design of freshwater and brackish water farms. Project formulation and layout. Different components of aquafarms – peripheral dikes, secondary dikes, feeder canals, sluice gate and monks. Various farm equipment. Pumps in aquaculture, different type of pumps.

UNIT 3: Hatchery facilities

Components and design of shrimp hatcheries – various components and infrastructure facilities required. Various hatchery equipment including aeration devices and pumps. Mechanical and biological filters.

UNIT 4: Aeration and oxygenation

Role of aeration in culture ponds. Paddle wheel aerators aspirators, compressors and blowers. Oxygen injection system

UNIT 5: Feeding System

Feeding systems: different types of feeding equipment, feed control systems, dynamic feeding systems.

UNIT 6: Water Treatment System

Water treatment: Equipment used for water treatment, filters, ultraviolet light, ozone, heating and cooling and other processes of disinfection

Text Books and References

1. Thomas B Lawson 2011. Fundamentals of Aquacultural Engineering, Springer
2. Wheaton, F.W. Aquacultural Engineering
3. Santhosh Kumar Garg 2018. Water supply Engineering
4. Bose et. al. 1991 Coastal Aquacultural Engineering

Course: DSE 1A **Course code: UAQC 354**

Title: HATCHERY TECHNOLOGY OF MARINE ORGANISMS

Hrs/week:6 **No. of Credits:4**

Unit 1: Carp Hatcheries

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

Unit 2: Carp Production System

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 broodfishes. Causes of mortality during transport, techniques of transport, open and closed systems, methods of transportation, use of anaesthetics. Bundh breeding- types, techniques and problems.

Unit 3: Seed Production of other Fishes

Seed production and nursery rearing of trout, air-breathing fishes, mullets, tilapia, pearl spot, sea bass, and groupers.

Unit 5: Live Feeds for Larvae

Culture of fish food organisms. Major phytoplankton groups- microalgal culture, laboratory methods- isolation, media preparation, kinds of culture- pure, crude, mass culture. Mass culture of *Chaetoceros. Artemia* – different strains, hatching, decapsulation, Production of Artemia cyst.

Unit 6: Hatchery Management

Components and general design of hatcheries. Selection criteria for broodstock and brood stock management. Water quality monitoring and management. Quarantine and disease management in hatcheries. Quality assessment of seeds.

Text Books and References

1. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. Daya Publishing House, New Delhi
2. CMFRI Spl. Bul. Hatchery Operation of Penaeid Shrimps
3. CMFRI sp Bul Artificial Reefs and Sea Farming Techniques
4. Jhingran VG 1998. Fish and Fisheries of India. Hindustan Publishing Corporation, NewDelhi
5. Pillay TVR, 1996. Aquaculture Principles and Practices, Fishing News Books Ltd.,

Course: DSE 2A **Course code: UAQC 355**
Title: CRAFT AND GEAR TECHNOLOGY
Hrs/week:6 **No. of Credits:4**

UNIT I

Fishing crafts: Fishing craft materials-introduction to fishing craft technology- Boat building material- wood, steel, aluminum, Ferro-cement, FRP (GRP)-advantages and disadvantages. Classification and description of different type of fishing crafts in India(inland and marine) traditional, motorized and mechanized. General arrangement and deck lay outs in different types of fishing boats, trawlers, gill netters, purse seiners, long liners, trollers, deep sea vessels. Classification of Marine corrosion

UNIT II

Classification of fishing gear (FAO and A. Von Brandt). Fishing gear materials- natural, synthetic materials, properties and preservation, yarn numbering systems, direction of netting, type of knots, meshes, fly meshing. Mounting and webbing different methods, hanging co-efficient. Fishing gear accessories- floats, sinkers, otter board, hook and ropes.

UNIT III

Active gears-Design and operation of - trawls, purse seines, ring seines, beach / shore seine, boat seine, pole and line, squid jigs, trolling. Passive Gears - Design and operation of- gill nets, long lines, hooks, traps, stake net, dol net, Chinese dip nets, cast nets.

UNIT IV

Destructive fishing methods like electrical fishing, poisoning and use of dynamites. Prohibited fishing practices. Factors affecting the design of fishing gears and fish catching methods.

UNIT V

FAD's, Fish finding devices and conservation: 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, echosounders, sonar, net sonde, gear monitoring equipment; remote sensing.

UNIT VI

Responsible Fisheries and Fisheries Legislation: 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, Aqua-ranching. Indian fisheries Act.1897. MFRAs, Maritime zones of India Act.1981, The Environment (Protection) Act, 1986, Biological diversity Act,2002.

Text Books and References

1. Brandt. A. v. (1984) Fish catching methods of the world. Fishing News Books Ltd.,London: 432 p.
2. Hameed, M.S. and Boopendranath, M.R. (2000) Modern Fishing Gear Technology, Daya Publishing House, Delhi:186 p.
3. Klust, G. (1982) Netting materials for fishing gear, FAO Fishing Manual, Fishing News Books (Ltd). Farnham, 192p.
4. Sreekrishna, Y. and Shenoy L. (2001) Fishing gear and craft technology, Indian Council of Agricultural Research, New Delhi.
5. FAO (1997) Fisheries management. FAO Technical Guidelines for Responsible Fisheries. No. 4. Fishery Resources Division and Fishery Policy and Planning Division, FAO. Rome: 82p.
6. FAO (1995) Code of Conduct for Responsible Fisheries, FAO, Rome: 41 p.4. FAO (1997) Inland fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 6 Fisheries Department, FAO, Rome: 36 p.

Course: DSE3A **Course code: UAQC 356**

Title: **MARINE BIOLOGY**

Hrs/week:6 **No. of Credits:4**

UNIT I

Intertidal ecology: Environmental factors. Adaptations. Intertidal community – Rocky, Sandy, Muddy shores: Environmental factors, Zonation, Feeding Biology, Community structure, Trophic structure. Tide pools.

UNIT II

Structure and Types of Seaweeds - Indian Seaweed Resources. Economic importance of seaweeds. Seagrasses: Diversity, Distribution and Importance. Mangrove ecosystems-Distribution. Structure and adaptations. Environmental condition. Zonations. Fauna. Major mangrove ecosystems in India. Conservation.

UNIT III

Deep Sea Biology: Environmental characteristics. Adaptations. Sampling strategy. Midwater community. Ecology. Zonation. Hydrothermal vents.

UNIT IV

Harmful Algal blooms: Harmful Algae. Ecology of Algal Bloom. Monitoring Algal Bloom. Seafood poisoning. Management and Mitigation.

Unit V

Marine reptiles - Adaptive radiation of marine reptiles – sea snakes and turtles. Marine birds– General characters, adaptation and importance of coastal and marine birds. Marine mammals - General characteristics, classification and evolution of cetaceans and sirenians. Distribution, adaptations and importance. Endangered marine mammals. Conservation strategies.

UNIT VI

Marine Biodiversity: Status of Global Marine Biodiversity. Status of Marine Biodiversity in India. Threats- over-exploitation, physical alteration, pollution, alien species. Biosecurity. Protected areas.Marine Biosphere Reserves.

Text Books and References

1. Castro, P. and M.E. Huber, 1997. Marine Biology, Second Edition. Mc-Graw Hill Company.
2. Greene, Thomas F. 2004. Marine Science: Marine Biology and Oceanography, 2nd Edition. Amsco School Publication, Inc.
3. Jeffrey S. Levinton, 2001. CD Marine Biology: Function, Biodiversity, Ecology pp. 515.
4. Laws, E.A.,2000. Aquatic pollution, an introductory text. John Wiley and Sons, Inc., New York, 639 pp.
5. Morrissey, J.F. and J.L. Sumich. 2012. *Introduction to the Biology of Marine Life*. Jones & Bartlett learning, U.K., 467pp.
6. Nybakken, J.W., and M.D. Bertness. 2004. Marine Biology - An Ecological Approach. Sixth Edition. Benjamin Cummings.

Course: DSE **Course code: UAQC 357**
Title: MARINE RESOURCE MANAGEMENT & ECOSYSTEM MODELLING
Hrs/week:6 **No. of Credits:4**

Unit I

Fishery resources – stock concept – stock definition – unit stock – mixed stock – characteristics; problems in assessing the marine resources in tropical waters –Indian marine fishes.

Unit II

Growth parameters; mortality parameters and selection parameters. Length frequency distribution - Pauly's integrated method - resolution of modes - growth estimation. Growth equation - methods, estimation; growth characteristics - uses. Mortality parameters -total instantaneous mortality, fishing mortality, natural mortality, methods of estimation. Fishing gear selectivity - selection parameters - gill net selectivity - trawl selectivity - methods - estimation - uses.

Unit III

Fish stock assessment models – surplus production models – VPA analysis, cohort analysis;

prediction models – Beaverton – Holt yield per recruit model – yield curves, Thompson - Bell model; FMSY, MEY, FMEY; Eumetric fishing, exploitation rate and ratio; estimation of potential yield.

Unit IV

Sampling techniques – types of sampling – sampling the fish units; fishing effort, standardization of fishing effort, catchability coefficient. Fishery management concepts, marine regulation acts relating to marine fisheries exploitation included in the final UNCLOS III treaty.

Unit V

Ecosystem modelling, ecosystem based fisheries management - principles; ECOPATH and ECOSIM models - estimation; simulation models -predator-prey model - NPZD model - software packages used in fish stock assessment and in ecosystem modelling

Text books & References

1. Chandra, P. 2007. Fishery Conservation Management and Development. SBS Publ.
2. Hall, S. J and B. Mainprize, Towards ecosystem-based fisheries management, Blackwell Publishing Ltd. Fish and Fisheries, 5 (2004) 1-20.
3. Michael, R.R. 1997. Fisheries Conservation and Management. Prentice Hall.
4. Moyle, P.B. and Joseph, J.C. Jr. 2000. Fishes – An Introduction to Ichthyology. 4th edn. Prentice Hall.
5. Pascoe, S. 2005. Bycatch Management and the Economics of Discarding. Daya Publ.

Course: Project I **Course code: UAQC 353 (Pr)**
Title: **INDUSTRIAL TRAINING**
Hrs/week **No. of Credits**

Educational tours and industrial vist are very important in several ways and one of them is that they help students to learn through direct perception of visual experience. This can be an interesting way to explore new things related to the academics. These tours motivate the students to have interest in learning. The study tour emphasizesexperimental learning and offer experience, both in group and self-directed activities that enable them to explore various hatcheries, cultures, practices and people.

The main aim of the Study Tour, hatchery visit and industrial training of Aquaculture students is aid to acquire basic knowledge of functioning of the hatching, breeding and rearing of aquatic organisms.

1. To visit hatcheries - RGCA, ADAK, RSH
2. Ten days industrial training programme from CIFT/MPEDA
3. To visit national Institutes- CMFRI, NIO, NBFGRI, NIPHAT, CIFNET etc
4. Preparation of study tour report.

Course: Project II & III (V & VI SEM COMBINED) **Course code: UAQC 354 (Pr)**
Title: PROJECT
Hrs/week: 2 + 2 **No. of Credits: 1 + 1**

With a view to develop creative thinking, team spirit and skill, a project work at preliminary level will be assigned to students, in groups. The project period is spread over about 10 months with a weekly work load of four hours. Project will be of a long assignment paper type, combined with field and lab work. Topics for project will be chosen from classical and applied fields.

It carries a maximum of 100 marks which include 20 marks for ICA, 70 marks for project report (valued by both External examiner and Internal Examiner- average mark will be calculated) and 10 marks for viva voce (valued by both External examiner and Internal Examiner- average mark will be calculated). The project report in the form of dissertation is prepared and submitted by the students will be evaluated by the External Examiner who attends to practical examination work, relating to semester VI. Head of the Department will chair the evaluation panel and proceedings of viva.

Course: Practical **Course code: UAQC 355 (P)**
Title: BIOSTATISTICS AND COMPUTER APPLICATION
Hrs/week:2 **No. of Credits:1**

1. Study of computer components and external storage devices.
2. Formatting a document using word, use of mail merge
3. Use of internet to collect fisheries data - FAO, NACA, ICLARM etc.
4. Descriptive statistical analysis using excel; calculation of mean, median, mode, standard deviation, standard error using computer programmes/packages
5. t- test, Chi –square, F- test, one way ANOVA, Data analysis using computer analysis (excel, free softwares) Analysis of fisheries/ biological data using computer programmes/packages.
6. Demonstration of FISHBASE

Course: Practical **Course code: UAQC 356 (P)**
Title: VALUE ADDED SEAWEED PRODUCTS
Hrs/week:2 **No. of Credits:1**

1. Taxonomy of commercially important seaweeds from your locality
2. Preparation of seaweed jelly
3. Preparation of seaweed soup
4. Preparation of seaweed ice creams
5. Preparation of seaweed face pack
6. Preparation of seaweed shampoo
7. Preparation of crude agar from selected seaweeds.

Course: DSE 1B **Course code: UAQC 363**
Title: FISH PATHOLOGY AND HEALTHMANAGEMENT
Hrs/week:6 **No. of Credits:4**

Unit 1: Protozoan Diseases
Introduction to fish diseases – pathology and parasitology – Definition and categories of diseases –Disease and environment. Protozoan diseases (finfish) – Ichthyophthiriasis, Costiasis, whirling diseases, trypanosomiasis. Shrimp diseases – Microsporidiosis, Gregaria disease, ecto- comensal protozoan.

Unit 2. Bacterial Diseases
Bacterial disease (finfish) – furunculosis, columnaris, bacterial gill disease, gill rot, Enteroredmouts, Edwardsiellosis, vibriosis, tail and fin rot, EUS. Shrimp disease – brown spot, black gill, filamentous bacterial disease, luminous vibriosis.

Unit 3: Fungal and Viral Diseases
Fungal diseases (finfish) – Saprolegniosis, Brachiomycosis, Ichthyophorus diseases, Lagenidium diseases – Fusarium disease.

Unit 4: Viral Diseases
Viral diseases (finfish) – IPN, IHN, Viral Hemorrhagic Septicemia, Spring Viremia of carps, CCVD, Carp lymphocystis – Major shrimp viral diseases – *Bacculovirus penaeii*, Monodon Bacculovirus, Bacculoviral midgut necrosis, IHHNV, Hepatopancreatic parvo like virus, Yellow head bacculovirus, white spot baculovirus.

Unit 5: Nutritional deficiency and Immunology
Nutritional pathology – lipid liver degeneration, deficiency diseases due to vitamin A, D , E,K, B-Complex, C, pantothenic acid, folic acid, biotin, choline, minerals. Aflatoxin and dinoflagellates. Antibiotic and chemotherapentants. Nutritional cataract. Genetically and environmentally induced diseases. Immunology, defence mechanism in fish and shell fish, Application and development of vaccines, Diagnostic tools – microscopy, immune detection DNA/RNA techniques.

Unit 6: Health Management
General preventive methods and prophylaxis against the occurrence of diseases. Goodpond management practices- Eco-friendly and sustainable aquaculture. Quarantine. Methods of pathological examination of fish and infectious diseases. Production of disease-free seeds. Evaluation criteria of healthy seeds. Good Feed management for healthyorganisms. Zero water exchange. Probiotics in health management.

Text Books and References

1. Biswas K.P. 2007 Prevention and control of fish and Prawn diseases –Narendra publishing House
2. B.K. Mishra, P. Swain, P.K.Sahoo, B.K.Das, N.Sarangi. Disease management in Fresh Water Pisciculture
3. Bose et al. 2019 Coastal Aquacultural Engineering
4. Roberts R.J. 2012. Fish Pathology.

Course: DSE 2B **Course code: UAQC 364**

Title: FISHERIES ECONOMICS, EXTENSION

Hrs/week:6 **No. of Credits:4**

UNIT I

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.

UNIT II

Aquaculture economics – Application of economic principles to culture operations. Various inputs. Production function - the laws of returns, returns to scale. Average, marginal and total revenues. Pricing-various factors influencing the price of a product. its assumptions in aquaculture analysis. Least cost combination of inputs, laws of variable proportions.

UNIT III

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.

UNIT IV

Extension education – its 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. Overview of fisheries and aquaculture sector in India and world; Special characteristics of fisheries sector and its stakeholders; Understanding extension education, research, and service; Overview of fisheries research, development and extension systems in India; Scope and importance of fisheries and aquaculture extension.

UNIT V

Aquaculture extension system -review of extension approach as practiced by DoF, FFDA, and BFDA; Market led extension approaches; Importance of Information and Communication Technology (ICT) in aquaculture extension system. Critical review of philosophy, principles, concepts, and practices of fisheries extension systems and approaches; Teaching, learning and co- learning.

Unit VI

Fisheries extension – advantages and limitations of present welfare and subsidy oriented extension systems; Development and extension approaches as practiced by public agencies like Department of Fisheries, KVKs, Agricultural Technology Management Agency (ATMA), NGOs, FAO, Bay of Bengal Programme (BOBP-IGO), and by the private sector; participatory fisheries extension approaches.

Text Books and References:

1. Badapanda, K.C. 2012. *Fishery Economics & Administration*. Narendra Publishing House, Delhi,427pp.
2. Cunninghams, M., R. Dunn & D. Whilmarsh. 1985. Fishery Economics - an introduction. Mansell publishing Ltd. London.
3. Dholakia, A.D. 2004. Fisheries and Aquatic Resources of India. Daya Publ.., Delhi,
4. Dunne EB. 1990. *Fisheries Economics - An Introduction*. Mansell Publ

Course: DSE 3B **Course code: UAQC 364**

Title: GENETICS AND BIOTECHNOLOGY IN AQUACULTURE

Hrs/week:6 **No. of Credits:4**

UNIT I

Introduction to Fish and Shellfish Genetics – Gynogenesis, Androgenesis, hybridogenesis, polyploidy, euploidy, interspecific hybridization, intraspecific crossbreeding, Monosex strains and their importance, sex reversal – mechanisms and applications; protrandrous, protogynous species and their importance; genotype environment interactions.

UNIT II

Genetic Engineering and Biotechnology in aquaculture- genetic improvement, selective breeding, transgenics and GMOs in aquaculture- reporter genes, AFP, disease resistance genes, growth hormone gene; gene transfer mechanisms, gene cloning.

UNIT III

Marker assisted selection, markers and their role in aquaculture biotechnology, DNA markers- RAPD, AFLP, RFLP, phenotypic markers, protein markers; microsatellite markers in fisheries research; gamete transfer mechanisms in crustaceans; artificial insemination and in-vitro fertilization in fishes and shellfishes; cryopreservation and its application.

UNIT IV

Biotechnological applications in pearl culture – genetic improvement, improvements in surgical techniques, biomineralization of nacre, tissue culture techniques.

UNIT V

Development and application of probiotics, prebiotics, bioremediators, immunostimulants, immunomodulators and vaccines – biofilm vaccines, DNA vaccines, recombinant vaccines. Hybridoma techniques; PAB's and MAB's in aquatic animal health management, Diagnostics and their application in aquaculture health management – immunodiagnostics, nucleic acid based diagnostics.

UNIT VI (10 hrs)

Introduction to Genomics and Proteomics; Bioethics with regard to biotechnological interventions in aquaculture sector- biodiversity and environment related issues, consumer issues associated with GMO's, economic issues, political issues, research issues, patents in biological research, biopiracy, Intellectual Property Rights (IPR) and their significance in aquaculture and fisheries science, documentation for patenting.

Text Books and References

1. Fingerman et al., 1999, Marine Biotechnology (Vol 1, 2 and 3)-. - Science PublishersInc, USA.
2. Karunasagar et al., 1999,- Aquaculture and Biotechnology –- Oxford and IBH, New Delhi
3. Fisheries Biotechnology – 2004 – Lakra et al., - Narendra Publishing House
4. A. R .Beaumont, 2 0 0 3 Biotechnology and Genetics in Fisheries and Aquaculture
5. Adams, A ,2001 Immunodetection methods in aquaculture.–
6. R.A. Dunham 2003, Aquaculture and fisheries biotechnology, a genetic approach – 2003-

Course: DSE **Course code: UAQC 366**

Title: AQUATIC MICROBIOLOGY

Hrs/week:6 **No. of Credits:4**

Unit I

General introduction to microbiology, Different members of the microbial community – General characteristics of bacteria, fungi, viruses, algae and protozoans. Ultrastructure of prokaryotic cell. Structure of fungi and yeast cell. Ultrastructure of virus, Life cycle bacteriophages - lytic and lysogenic cycle.

UNIT II

Aquatic microbiology - importance and significance. Microflora of aquatic environment, Isolation and cultivation of microorganisms from water and sediment. Different culture techniques. Different types of media for isolation of bacteria and fungi. Identification based on Morphological, Physiological and Biochemical characteristics.

UNIT III

Prokaryotic growth–characteristic features of bacterial growth curve–Effect of environmental factors on growth. Influence of physicochemical factors on the distribution and abundance of aquatic microorganisms. Microbial nitrogen fixation; Roles of microbes in biogeochemical cycles: Carbon, nitrogen and phosphorus cycle. Decomposition of organic matter.

UNIT IV

Microbiology of culture pond – role of autotrophic and heterotrophic microorganisms in culture pond. Nutrient regeneration in pond, role of microbes in biogeochemical cycles – Nitrogen, phosphorus and sulphur cycles. Autochthonous and allochthonous microorganisms in culture pond.

UNIT V

Indicator of Aquatic Pollution - Fecal coliforms; Prevention and control. Microbial communities in the aquatic environment. Biofilms and Biofouling. Biocorrosion. Microbial interactions, symbiosis and antagonism.

UNIT VI

Microbial biodegradation - natural and synthetic material in the aquatic environment. Hydrocarbon, Heavy metals, Pesticides, Plastics, Lignin, Cellulose degradation. Marine Extremophiles: adaptive mechanisms in thermophilic, alkalophilic, osmophilic, barophilic, psychrophilic microorganisms. Hyperthermophiles and Halophiles,

Text books and References

1. Austin. B, and D.A Austin 1999. Bacterial Fish pathogens- Diseases of Farmed and Wild Fish. Springer.
2. Dhevendaran, K. 2008. Aquatic Microbiology. Southern Book Star, TVM, 242 pp.
3. Dworkin MM, S Falkow, E Rosenberg, K-H Schleifer and E Stackebrandt (Eds). 2006. The Prokaryotes: A Handbook on the biology of Bacteria. Vol. 1-6. Springer and Verlag New York.
4. Kirchman, D.L. 2008. Microbial Ecology of the Oceans John Wiley and Sons.
5. Pomerville & Jeffrey, 2011. *Alcamo's Fundamentals of Microbiology.* Johns & Bartlett Publishers, Boston, 855pp
6. Salyers, A.A. & D.D. Whitt 2001. Microbiology, Diversity, Disease and the Environment. Fitzjerald Sci. Press, Maryland, 608 pp.
7. Sigee & C. David. 2005. *Freshwater Microbiology*. John Wiley & sons Ltd., England, 524pp.

Course: DSE **Course code: UAQC 367**

Title: PLANKTONOLOGY AND ALGOLOGY

Hrs/week:6 **No. of Credits:4**

Unit I

Plankton - classification, ecology and interrelationships. Sampling and preservation techniques. Plankton nets and recorders; catching efficiency of various nets and quantitative analysis. Plankton fixatives and preservatives.

Unit II

Phytoplankton in the marine environment – classification, ecology, physiology, spatial and temporal distribution, changes in distribution patterns in different ocean ecosystems. Phytoplankton pigments, photosynthesis and primary production, Algal blooms. Role of phytoplankton in global carbon cycle – impacts of climate change.

Unit III

Zooplankton in the marine environment – distribution and abundance, classification, major groups of zooplankton, micro-zooplankton, and secondary production, trophic structure, swarms, indicator species, predator-prey relationship; grazing in the aquatic ecosystem, vertical migration of zooplankton, DSL, bioluminescence, importance of meroplankton.

Unit IV

Macro-algae of Indo-Pacific region. Major species, spatial and temporal distribution patterns. Zonation and adaptations. Seaweed culture. Economic uses.

Unit V

Microalgal culture- techniques for the culture of Skeletonema, Chlorella, Arthrospira, Chaetoceros. Commercial application of microalgae.

Text books and References

1. Colin Reynolds, David Thomas, Peter Williams. 2002. Phytoplankton Productivity: Carbon Assimilation in Marine and Freshwater Ecology.402 pp.
2. Goswami, S.C. 2004. Zooplankton Methodology, Collection & identification – A fieldmanual. NIO Goa.
3. Mitra, A. 2006. Introduction to Marine Phytoplankton. Narendra Publ.
4. Pillai, N.K. 1986. Introduction to Planktanology. Himalaya Publ. House.
5. Smith, DeBoyd L. 1996. A Guide to Marine Coastal Plankton and Marine InvertebrateLarvae. Dubuque, IA: Kendall/Hunt Publishing Company.
6. Tomas, C.R. 1997. Identifying Marine Phytoplankton. Academic Press.

Course: Practical **Course code: UAQC 366 (P)**
Title: AQUATIC MICROBIOLOGY
Hrs/week:2 **No. of Credits:1**

1. Sterilization technique- dry heating, autoclaving
2. Media preparation
3. Isolation and maintenance of bacteria from fishes and water samples.
4. Gram staining of bacteria
5. Enumeration of bacteria by TPC method
6. Enumeration of total coliforms from the water sample.
7. Study of Bacterial motility

Course: Practical **Course code : UAQC 367 (P)**
Title: PLANKTONOLOGY AND ALGOLOGY
Hrs/week:2 **No. of Credits:1**

1. Draw different types of phytoplankton and zooplankton (10 each)
2. Collection and preservation of plankton samples
3. Quantitative estimation of phytoplankton
4. Identification of various phyto and zooplankton
5. Microalgal culture (select any one)

GENERIC ELECTIVE

Course: GE I **Course code : UAQC 358**

Title: **BIOSTATISTICS**

Hrs/week:4 **No. of Credits:3**

Unit I (5 hrs)

Types of Biological Data, Data collection-primary and secondary data, sampling methods, organization of biological data, editing, classification and tabulation

Unit II

Presentation of data - Diagrammatic representations of biological data – one-, two- and three-dimensional diagrams.

Unit III

Measures of Central tendencies and its applications for biological variables. Measures of Dispersion and its applications - coefficient of variation.

Unit IV

Skewness and Kurosis, Application of Skewness in Biological Data, Correlation and regression analysis in Biological Data, Probability, Permutation and Combinations.

Unit V

Correlation and Regression, Distributions-Standard Error, Binomial, Poisson and Normal Distributions-applications in Biological Data, Hypothesis testing and its applications in biological data-Null and Alternate Hypotheses-Errors in Hypothesis testing.

Unit VI

Large and small sample tests in Biological Data-Z, ‘t, and F tests- Chi Square Tests-Analysis of Variance applications in Biological Data-One- and Two-way ANOVA.

Text Books and References:

1. Aitken, Mike, Braadhurst, Bill, Hladky, Steve. 2009. *Mathematics for Biological Scientists*. Garland Science Publishing, New York, 208pp.

2. Elhance, D.N. & V. Elhanle 1983. Fundamentals of Statistics. Kitab Mahal Publ., India

3. Finney, D.J. 1978. Statistical Methods in Biology Assay. Charles Griffith Co. Ltd., England, 508 pp.

4. Ghosh S. 1999. *Multivariate Analysis, Design of Experiments and Survey Sampling*. Marcel Dekker.

5. Grafen, A. & R. Hails 2008. Modern Statistics for the Life Sciences. Oxford Univ. Press, NY, 351 pp.

6. Kothari, C.R. 2011. *Research Methodology: Methods & Techniques*. New Age International Publishers, New Delhi, 401pp.

7. Walpole, R.E. 1968. Introduction to Statistics. The MacMillan Co., NY, 365 pp.

Course: GE I I **Course code: UAQC 368**

Title: MARINE DRUGS and PROSPECTING

Hrs/week: 4 **No. of Credits:3**

Unit I

Bioactive compounds, bioactive marine natural products – significance –antitumor – anti cancer – anti-inflammatory – analgesic – anti-viral agents – antibiotic – cytotoxic – antimicrobial compounds.

Unit II

Collection of marine organisms - Isolation and separation of marine natural products from marine flora and fauna

Unit III

Diversity of bioactive metabolites in different groups of marine organisms- corals, sponges, marine fungi, bacteria, endosymbionts, marine algae etc.

Unit IV

Marine microorganisms as a source of biomedical resources – dinoflagellates as a source of bioactive molecules –marine toxins – saxitoxin – brevitoxin – ciguatoxin – tetradotoxin

Unit V

Nitrogen and non-nitrogen containing marine bioactive compounds – polyketides – prostanoids – polyethers – macrolides – terpenes. Commercial development of marine natural products – chitosan - algal products – SCPs - β carotene – vitamins

Unit VI

Biological and toxicological aspects of marine natural product drug discovery, Clinical evaluation of MNPs in drug discovery.

Text Books & References

1. Bakhuni, D.S. and Ravat, DS 2020. Bioactive marine natural products. Springer

2. Kornprobst Jean Michel, 2010. Encyclopedia for marine natural products. Wiley Balckwell, 1680pp

3. Kiyota, H. 2020. Marine natural products. Springer Nature, 301pp.

ABILITY ENHANCEMENT COURSES
(COMPULSORY)

Course: AECC-1 **Course Code: COMP 113**

Title: COMPUTER APPLICATION

Hrs/Week:2 **No. of Credits:2**

Unit I

Types of Computers. Binary Number System, Digital and Analog systems. Hardware/Software/Firmware. Basics of Computer Functioning- Booting; Formatting; File, File Extensions; Temporary Files; Folder; GUI, Icon; Installation of Programs, Commands, Bios-setup, Date and Time, Memory Partitions, Registry, Default Operations; Defragmentation (Brief account only).

Unit II

Memory -Classification and Types of memory; memory devices; Units. Input Devices - Types, working and functions. Output Devices –Types, working and functions. CPU components Processors, Mother boards, SMPS, Accessory Cards –Graphic /Sound/ Networking/Bluetooth/Wifi (Brief account only).New Generation Computers - Servers, Laptop; Palmtop; Cyborgs; Robotics, Zoobotics (Brief account only).

Unit III

System Software/Operating System -System Files; Working of OS; DOS, Widows, Linux and UNIX (Brief account only). Application Software -Programs and Packages, Calculator, MS Paint, MS Word, MS Excel, MS PowerPoint, Publisher, Acrobat Reader, E Book Reader, Explorer, Photoshop. Virus and Antivirus (Brief account only). Statistical Software (MS Excel, SPSS, R).

Unit IV

Computer Communication -Network Topology, Media of networking, Networking Protocols, PAN, LAN, WAN, MAN, INFLIBNET, Modem and Gateway. Internet and Internet Services - World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines, Firewall. Global Information System -BIOSIS, Medline and Medlars, AGRIS; E Journals and E Books Publishing. Cyber Crime and Cyber Laws (Brief account only).

Unit V

Use of bar diagram, histogram, scatter plots, Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD, word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc; Introduction to Power Point, preparation of presentations.

Unit VI

Remote sensing and GIS: Definition and principle of remote sensing and GIS. Sensing mechanism. Analysis of images and data. Fisheries forecasting system in India and other countries. GPS. Application of remote sensing and GIS in fisheries conservation and management of fish faunal diversity and exploitation of capture fisheries.

Text Books

1. Computers Today by Suresh K. Basandra 1999. Published by Galagotia Publications, Pvt. Ltd., New Delhi.
2. Shane Torbert.2011. *Applied Computer Science*. Springer-verlag, New York.
3. Sudipto Das.2010. *A Complete Guide to Computer Fundamentals*. Lakshmi Publishers (P) Ltd. New Delhi
4. Sundar Rao,P.S.S and J.Richard.2006.*Introduction to Biostatistics and Research Methods* (4th edn). Prentice Hall, New Delhi.
5. WHO.2011. *Laboratory Quality Standards and Their Implementation*. WHO Regional Office. New Delhi.
6. Zar, Jerrold H. 2008 (3rd edn.). *Biostatistical Analysis*. Pearson Education Inc., Delhi.

Course: AECC-2 **Course Code: COMP 123**

Title: BIODIVERSITY – CONSERVATION AND MANAGEMENT

Hrs/Week:2 **No. of Credits:2**

Unit I

Definition and types of biodiversity - Ecological, Genetic and organismal diversity; importance of biodiversity. Mega biodiversity countries, biodiversity hotspots – global and Indian.

Unit II

Marine biodiversity. Present status of marine biodiversity in India. Island biodiversity. Causes of biodiversity loss. Measuring Biodiversity - Margalef species richness, Simpson's dominance, Pielou's evenness and Shannon-Weiner diversity indices. Software's for biodiversity assessment. Biodiversity documentation.

Unit III

Methods in documentation. Para taxonomy in biodiversity inventory. Extinct, endangered, threatened and vulnerable species – Red List. Zoological Survey of India (ZSI) and its role in marine biodiversity documentation.

Unit IV

Impact of alien species, GMOs and exotic species on endemic biota. Threats to marine biodiversity. Census of Marine Life. Conservation methods, ex-situ and in-situ conservation. Levels of conservation – alpha, beta and gamma.

Unit V

Protected areas, national parks, wild life sanctuaries, reserves, MPAs. Marine National parks of India. Social, ethical and policy issues in biodiversity conservation.

Unit VI

International treaties and global efforts for management of genetic resources relating to biodiversity. CBD, Ramsar Convention 1971, Indian Biodiversity Act 2002, National Biodiversity Authority of India. National bureaus dealing with genetic resources – NBPGR, NBAGR, NBAIM, NBAII and NBFGR. Organizations involved in protection and conservation – CITES, IUCN, WWF for Nature, UNEP.

Text books and References

1. Carson, R. 1991. The Sea Around Us. Oxford University Press, 288 pp.
2. Côté, I.M. and Reynolds, J. D. (Eds.) 2006. Coral Reef Conservation. Conservation Biology No. 13. Cambridge University Press.
3. Glover, L.K. and Earle, S. (Eds.) (2004). Defying ocean's end: an agenda for action. Island Press, Washington D.C., 283 pp.
4. McLeod, K. and Leslie, H. (Eds.) 2009. Ecosystem-based Management for the Oceans, 2nd edn., Island Press, 392 pp.
5. Norse, E.A. and Crowder, L.B. (Eds.) 2005. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity,1st edn., Marine Conservation Biology Institute. Island Press, 496 pp.
6. Ray, G.C., McCormick-Ray, J., Smith Jr., R.L. 2013. Marine Conservation: Science, Policy, and Management.1st edn., Wiley-Blackwell, 384 pp.

GENERAL COURSES

Course: GEN 1 **Course Code : RESM 211**

Title: RESEARCH METHODOLOGY

Hrs/Week:5 **No. of Credits:3**

Unit I

Topic selection - Planning research – defining objectives - Preparation of work plans. Identification of suitable methodology - Preparation of project proposal –Summer Schools – Training in research institutes

Unit II

Collection of literature- News articles – Newsletters – Magazines – Books - Journals. Digital library and search of articles - Keywords and search - Internet – Google Scholar – PubMed – Inflibnet – Medline – Agricola – Science direct -Open access Journals - virtual sources – other sources. Short communications –review articles

Unit III

Collection of protocols and selection of suitable methods according to work plan. Observational and experimental research. Data analysis – Construction of tables – headings - footer - Tabulation – Presentation of results - Use of statistical software to analyze the results- SPSS.

Unit IV

Thesis structure –Components - Writing Introduction – review of literature – Materials & Methods – Presentation of results – Discussion of Results based on literature – Arriving at conclusions – Preparation of Summary/abstract – Arrangement of Bibliography and how to quotereference in thesis - Appendix.

Unit V

Publishing of Articles in newspapers /newsletters - Selection of journals – ISSN Number – Peer-reviewed Journals – Science citation index – impact factor and importance. Manuscripts preparation for Journals – components – Plagiarism - Submission and Publication – reprints and pdf formats. Paper presentation in Conferences.

Text Books and References

1. Booth W. C. et al. 2016. The Craft of Research. University of Chicago Press.
2. Gurumani, N. 2006. Research Methodology for Biological Sciences.MJP.Publishers.
3. Marczyk, G., DeMatteo, D., Festinger, D. 2005. Essentials of research design and methodology.John Wiley.
4. Katz, M. J. 2009. From Research to Manuscript: A Guide to Scientific Writing. Springer.
5. Michael Alley. The Craft of Scientific Writing (3rd Edition) Publisher: Springer.
6. Cargill, M., O.Connor, P. 2013. Writing Scientific Research Articles: Strategy and Steps. Wiley-Blackwell.

Course: GEN 2 **Course Code : RESM 212**

Title: NATURAL RESOURCE MANAGEMNT

Hrs/Week:5 **No. of Credits:3**

Unit 1:

Definition of natural resources. Types of natural resources. Need for protecting natural resources. Concept of sustainable utilization. Economic, ecological and socio-cultural approaches.

Unit 2

Agricultural, pastoral, horticultural and silvicultural land utilization. Soil degradation and soil management. Fresh water (rivers, lakes, groundwater); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 3

Biodiversity-definition and types; Significance; Threats; Management strategies. Bioprospecting. National Biodiversity Action Plan.

Unit 4

Definition. Types of forests. Forest cover and its significance (with special reference to India); Major and minor forest products; Forest depletion. Forest Management. Renewable and non-renewable sources of energy.

Unit 5

Environmental Impact Assessment, Remote Sensing, Geographic Information System, Participatory Resource Appraisal. Ecological footprint with emphasis on carbon footprint. Resource Accounting. Waste management.

Unit 6

National and international efforts in natural resource management and conservation

Text Books & References

1. Singh K. K. 2008. Natural Resources Conservation & Management. M D Publications Pvt. Ltd.

2. Rogers, P.P., Jalal, K.F. and Boyd, J.A. 2008. An Introduction to Sustainable Development. Prentice Hall of India.

3. Lynch D. R. 2011. Sustainable Natural Resource Management. Cambridge University Press.

4. Nuberg, I., George, B., Reid, R. 2009. Agroforestry For Natural Resource Management. CSIRO Publishing.

5. Camp, W. G., Heath-Camp, B. 2016. Managing Our Natural Resources. Cengage Learning Pte. Ltd

6. Chiras, D. D., Reganold, J. P. 2009. Natural Resource Conservation: Management for a Sustainable Future. Pearson.

Course: GEN 3 **Course Code : CRM 221**

Title: CORAL REEF AND MANGROVES - ECOLOGY AND CONSERVATION

Hrs/Week:5 **No. of Credits:3**

Unit I

Coral reefs – Types, structure and distribution in world oceans. Zonation and limiting factors. Factors influencing the growth, productivity, reproduction, larval dispersal and settlement of corals. Major species of corals in India. Protected coralreefs.

Unit II

Ecology of coral reefs: Major reef communities, species interactions, foodchains and food webs, symbiotic relationships. Ecology of reef fishes. Natural processes and succession in coral reefs, Interactions with adjacent ecosystems. Degradation and destruction of coral reefs: impact of climate change and anthropogenic interventions including destructive fishing practices.

Unit III

Coral reef conservation measures. Activities of various organizations in coral reef conservation and management. Ecosystem services of coral reefs.

Unit IV

Mangrove ecosystems. Distribution of mangroves – global, regional and local levels. Major species of mangroves. Mangrove diversity, zonation and adaptations. Faunal and floral communities in mangrove ecosystem, food chains and food webs. Ecosystem services of mangroves.

Unit V

Conservation and management: principles of ecological restoration –habitat enhancement, afforestation; Mangrove conservation activities around the world; Useof Remote Sensing and GIS techniques for mapping mangrove distribution; Joint Mangrove Management (JMM) programme.

Text books and References

1. Bakus, G.J., 1994. Coral reef ecosystems. Oxford and IBH publishing Company, New Delhi: 232 p.
2. Mark D. Spalding, Edmund P. Green, Corinna Ravilious. 2001. World Atlas of Coral Reefs.University of California Press 430 pp.
3. McClanahan T. R., C. R. C. Sheppard, D. O. Obura. 2000. Coral Reefs of the Indian Ocean: Their Ecology and Conservation. Oxford University Press, USA 550 pp.
4. Naskar, K. 2004. Manual of Indian Mangroves. Daya Publishers, New Delhi. 220 p.
5. Singh, V.P. and Odaki, K. 2004. Mangrove ecosystem: structure and function. Scientific Publishers, New Delhi: 297 p.
6. Yuri I. Sorokin. 1993. Coral Reef Ecology. Springer-Verlag Berlin Heidelberg 475pp.

Course: GEN 4 **Course Code: OCEA 222**

Title: Oceanography

Hrs/Week:5 **No. of Credits:3**

UNIT 1

Earth and ocean floor: Origin. Structure of earth. Continental Drift. Paleomagnetism. Plate tectonics. Major ecological zones of oceans. Physical properties of sea water latitudinal land vertical distribution of temperature, salinity and density, seasonal thermocline. Light penetration- colour of the sea, concept of extinction coefficient, sound propagation, SOFAR channel and shadow zone.

UNIT II

Concept of water masses in Arabian Sea and Bay of Bengal. Pressure gradient force-Coriolis force. Ekman current- Ekman spiral. Coastal upwelling and sinking- importance to fisheries. Concept of thermohaline circulation- equatorial current system, great gyres and westward intensification, Peru Current and El-Nino. Catastrophic effects of El-Nino. Wind waves- characteristics, generation, wind speed, fetch and duration. Sea and swell. longshore currents and rip currents. Tides- influence of sun and moon, spring and neap tides.

UNIT III

Characteristics and importance of beaches, Classification of marine environment: Continental shelves, slopes, rises. Submarine canyons. Abyssal plains and hills. Ocean trenches. Island arcs. Ocean Ridges. Seamounts. Guyots.

UNIT IV

Oceanographic equipment's- meter wheel, messenger, winches etc. Water samplers-Nansen, Van-dhron and Niskin bottles. Temperature measurements- reversing thermometers, MBT, XBT, CTD. Composition of sea water- major and minor elements, salinity, chlorinity, concept of constancy of composition. Dissolved gases- oxygen, carbon dioxide and hydrogen sulphide.

UNIT V

Oceanography in relation to fisheries. Application of GIS in fisheries. Coastal zone management. Application of remote sensing in coastal zone management. Coastal zone regulation.

UNIT VI

Marine Pollution: Definition. Categories of Pollution – Oil, Heavy Metals, Pesticides, Sewage, Radionuclides, Thermal, Synthetic organic chemicals. Antifouling paints. Plastics and Trash. Toxicity.

Text books and References

1. Thurman, H., 2001. Introduction to Oceanography, Prentice Hall Inc. New Jersey.
2. Paul. R. Pinet, 2006. Invitation to Oceanography, 4th Edition. Jones and Bartlett, Sudbury, Massachusetts.
3. Sverdrup, H.U., Johnson, M.W. and Fleming, R.H., 1958. The Oceans- their Physics, Chemistry and General Biology, Prentice- Hall Inc. New Jersey.
4. Pickard, G.L. and Emery, W.J., 1995. Descriptive Physical Oceanography. Pergamon Press, London.
5. Millero, F.J., 2006. Chemical Oceanography. CRC Press, New York.
6. Pilson, M.E.Q., 1998. An introduction to the chemistry of the sea. Prentice Hall Inc., New Jersey.