


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

Bachelor of Fisheries Science (B.F.Sc.)
(Four- Year) Programme

Regulations & Curriculum

2019-2023

CAS in Marine Biology
FACULTY OF MARINE SCIENCES

**REGULATIONS FOR THE FOUR YEAR PROFESSIONAL PROGRAMME
UNDER CHOICE BASED CREDIT SYSTEM (CBCS)**

I. Title and Scope

1.1 These academic Regulations shall be called “ Annamalai University, Faculty of Marine Sciences “B.F.Sc. Academic Regulations 2019” for obtaining Bachelor Degree in the Faculty of Marine Sciences.

1.2 The regulations provided herein shall apply to the students admitted from the academic year 2019-2020 onwards

2. Definitions

2.1 University: University means Annamalai University, Parangipettai, and Tamil Nadu.

2.2 State Government: State Government means the Government of Tamil Nadu.

2.3 Academic Year: An academic year is a period during which a cycle of study is completed. It shall commence on or after 1st July of each year. There shall be two semesters in an academic year.

2.4 Semester: A semester shall consist of 105 working days inclusive of the mid-semester and practical examinations.

2.5 Curriculum: It is series of courses offered to provide learning opportunities to meet the requirements for a degree.

2.6 Course: A course is a unit of instructions, series of classes and work experience extending over a semester. It has a specific prefix, code number, title and credits. Each course is denoted by specific code number, which has specific meaning. The first three alphabets stand for the department offering the course. First digit is related to the semester; second digit is related to suffixing the semester and the third digit is related to course number in a particular semester i.e “BFSC 201 – Taxonomy of finfish”. BFSc stands for the Bachelor of Fisheries Sciences the first digit (2) stands for the second semester and the third digit stands for serial number of course in a particular semester.

2.7 Credit: It is a measure of quantity of work done in a course. One credit represents one contact hour for theory or two contact hours of laboratory or field work per week. For example, a 1 + 1 course (2 credits) means 1 hour theory and 2 hours practical per week.

2.8 Credit load: It is the number of credits a student undergoes in a semester.

2.9 Grade Point: “Grade Point” means the total marks in percentage divided by 10 and shall be expressed on 10 point scale up to second decimal place.

2.10 Credit Point: A credit point is a product of grade point obtained by a student and number of credits in a course.

2.11 Grade Point Average (GPA): It is a measure of performance of a student in all the courses taken during a semester. The GPA is computed by dividing the total credit points earned by a student in a semester by the total number of credits taken during that semester.

2.12 Calculation of OGPA: To arrive at the “Overall Grade Point (OGPA)” at the end of a semester, the grade point of each course is multiplied by the credit hours of the course to obtain the credit points. Then, the sum of the credit points secured by the students in all the courses taken till the end of that semester is divided by the number of credit hours of the courses, provided that the credit hours and credit points of courses which are repeated are not counted more than once for this purpose.

a. Grade Point of a course: To calculate the grade point of a course, the marks obtained for theory (100 marks) and practical (50 marks) will be revised to 100. The Percentage of mark earned in a course is then divided by 10 and expressed in a 10 point scale up to one decimal place.

b. Credit point of a course: It is the product of credit hours and grade points obtained by the student in a course. For example: In a course with credit 2+1, if the grade point is 8.5; then the credit point of the course is $3 \times 8.5 = 25.5$

c. Grade point average: It is quotient of the total credit points obtained by the student in various course at the end of each semester divided by the total credit hours taken by the student in that semester. The grading is done on a 10 point scale.

2.13 Overall grade point average (OGPA): It is the quotient of cumulative credit points obtained by a student in all the course from the beginning of the first semester of the degree course divided by the total credit hours of all the courses completed up to the end of the semester. The OGPA shall be rounded off to second digit of decimal point on the basis of third digit. If third digit of decimal point is 5 or more than 5, then second digit will be increased by one. If, however, it is less than 5, it will be ignored. This will be done at the end of each semester while calculating the OGPA. Marks or Grade scored in the ELP, All India Study tour and IPT will be taken into account for OGPA calculations.

For example

- i. Total credit hours till the end of last semester: 18
- ii. Total credit points till the end of last semester: 140.50
- iii. Total credit hours in the current semester : 22
- iv. Total credit points obtained in the current semester : 156
- v. Total credit hours including the current semester : $(18+22) = 40$
- vi. Total credit points including the current semester : $140.50+156.00=296.50$
- vii. Overall Grade Point Average: $(296.50/40) = 7.412$
- viii. Corrected to two decimals : $7.41/10.00$

Classification of Successful Candidates: The successful candidates who after completion of the graduation requirements, have secured an OGPA of 5.000 or more in the 10.000.00 point scale shall be classified as under (2019-2020 admitted batch)

OGPA	Division/Class
5.000-5.999	Pass
6.000-6.999	Second
7.000-7.999	First
8.000 and above	First with Distinction

Experimental Learning Programme (ELP) and its evaluation

For ELP, all working days including Sundays, but excluding Government holidays will be counted for the attendance. The attendance requirement shall be 95% in ELP if a student absent himself/herself up to 7 days, the duration of the semester has to be extended accordingly for such students and final evaluation shall be done on completion of the attendance requirements. Evaluation shall be done after the completion of 105 working days as per the evaluation criteria suggested by ICAR. A student should score above 70 marks to get satisfactory grade and below 70 marks is not satisfactory. Those who have obtained “not satisfactory” grade have to repeat the ELP Programme when it is offered by the University.

In Plant Attachment / In Plan Training (IPT) and its Evaluation

Student who register of IPT during the 7th semester and All India Study Tour. Attendance requirements and evaluation are similar to that given for ELP Programme.

All India Study Tour

Students should compulsorily undertake the All India Study Tour during seventh semester for a period of 4 weeks. The performance will be evaluated by the teacher in charge of the tour at end of 30 days time on the basis of reports submitted by the students.

Re-registrations:

Students shall be given any number of attempts to clear the arrear subject keeping the checks for movement from one year to another i.e. students are permitted to register for the succeeding semester even without clearing the course up to 6th semester.

2.14 “Transcript Card” is a consolidated report of grades secured by the student in all the semesters, issued by the University.

3. Admission

3.1 Admission of the student to BFSc programme in the Faculty of Marine Science shall be on the basis of merit and in accordance with the policy and guidelines of the state government and the University. The minimum admission requirement shall be decided by University and issued from time to time. Decision of the University is final in deciding procedure of admission and finalization of number of seats. Reservation rules shall be made applicable as per norms of the state government.

3.2 Tuition fees and scholarship:

The various fees payable by the students will be decided by the University from time to time.

- a) In case of new admission, the fees for the semester are payable in advance failing which they will not be admitted.
- b) In other cases, the fees are payable within seven working days from the commencement of the semester.
- c) In the case of default, a fine as per the University rules will be collected.
- d) The students who fail to pay the tuition fees within a month of commencement of the semester will not be allowed to attend the classes and their names will be struck off from the rolls. However, if the defaulting students pay the fees along with the fines in addition to a prescribed readmission fee, they will be permitted to attend the classes. The period for which his/her name is struck off from the rolls will be treated as absence for the purpose of calculating the minimum attendance requirements.
- e) Students who are away on study tour, camp activities or other extracurricular activities organized by the University or the Faculty at the Commencement of the semester may, however, pay their semester tuition fees and other fees within the third working day after they return from such programmes, without fine.
- f) A student who has been granted scholarships by the Welfare Departments or by the Government of India or by the State Government will, however, be exempted from the levy of fines, provided the fees are paid on the next day after the scholarship amount is actually disbursed to him/her. The concession referred above will apply to those who have actually been granted scholarships and not to those who have only applied and are expecting sanction.

g) The candidate should obtain a Hall ticket from the Controller of Examinations through the Dean after clearing all arrears including the hostel dues before the commencement of each semester final examination.

4. Advisory system

4.1 Dean shall nominate a co-ordinator from amongst the teaching faculty.

4.2 Student ward counsellors will be nominated soon after the students admission. The counsellor shall be nominated from amongst the teaching faculty.

5. Curriculum and programme of study

The students admitted in the University shall be required to follow the curriculum as prescribed, revised by the Faculty and approved by the Academic Council from time to time.

6. Award of Degree, duration and credit requirements

A student is required to complete the duration and credit requirement for the award of degree as decided by Academic Council from time to time.

Sl.No.	Degree	Duration requirements		Credit requirements
		Min.	Max	
1	B.F.Sc	8	16	182

7. Medium of Instruction

The medium of Instruction in Bachelor of Fisheries Science shall be English

8. Attendance Requirements

8.1 One hundred percent attendance is expected from each student. A student who fails to secure 80 percent if attendance prescribed for a course (subject) to study, separately in theory and practical shall not be permitted to appear for both theory and practical examinations in that course (subject) and shall be given 'E' (incomplete) and will be required to repeat the course (subject) when offered again.

8.2 For the first year first semester students, for calculating 80 per cent attendance the number of working days will be calculated only from the date of joining of the student.

8.3 If any student is absent for field trips, the student may be marked absent for all the compensating classes on the day of the field trip in addition to the field trip courses.

- 8.4** The attendance for mid semester examination will be counted as a theory class.
- 8.5** Students abstaining from the classes by prior permission from the Dean, Faculty of Marine Sciences on official University business, shall be given due consideration in computing attendance requirements.
- 8.6** However, condonation of attendance deficiency may be considered by the Vice-Chancellor only in case of genuine reasons including indoor hospitalization with evidence in the form of Hospitalization certificate and Discharge summary recommended by the Dean, Faculty of Marine Sciences. The Vice-Chancellor may decide whether or not a condonation fee is required, based on the reason for condonation.

9. Examinations

Students shall have to take up an internal evaluation test between 50th and 60th working days of the semester; a final practical examination towards the end of the semester within 105 working days; and a final theory examination on completion of 105 working days for the successful completion of each course registered in the semester.

For the courses with theory and practical, 100 marks are allotted for theory and 50 marks for practical. Out of 100 marks for the theory, 80 marks are allotted for the final theory examinations and 20 marks for internal evaluation. For the courses with theory alone, 100 marks are allotted for the theory. For the courses with practical alone, out of 100 marks, 25 marks are allotted to record/ assignment, 25 marks of viva- voce and 50 marks for the practical.

Each course shall carry a maximum of 150 marks for the purpose of grading. The distribution of marks shall be as follows

9.1. Course with both theory and practical Marks

- i) Mid Semester Examination 20
- ii) Practical Examination (Written =35, 50
 Record = 10 and Viva-voce = 5)
- iii) Final theory examination 80

Total 150

9.2 Course with only Theory / practical * Marks

- i) Mid semester Examination 20
- ii) Final semester Examination 80

Total 100

* The modality of evaluation of various courses with only practical is given in Regulation 9.4

9.3 Evaluation of course work

The results of the course shall be indicated by grade points ranging from 0 to 10.00. The minimum grade point to be secured for the successful completion of a course will be 5.00. Securing a grade point less than 5.00 in a course will be treated as “RA’ and the grade point will be 0 for calculating the GPA / OGPA. In case of course with theory and practical, minimum of 50% mark separately in theory and practical with an aggregate of 50 percent is essential. An OGPA of 5.50 shall be the minimum requirement for the award of Degree.

The following symbols shall be used in the grade sheets.

E - Incomplete (due to attendance deficiency)

AB - Absent

RR - Re- registration

RA - Re – appearance

IE - Improvement Examination

EE - Incomplete for reasons other than attendance

R -Reappear

GPA - Grade Point Average

NC - Non CreditPaper

9.4. Evaluation pattern for courses with only Practical

The evaluation pattern of courses with only practical is grouped and mark distribution is furnished below.

10. Mid – semester examination (MSE)

10.1. Writing the mid –semester examination is a pre- requisite for writing the final theory and practical examinations, If a student does not appears for MSE, he /she is not eligible to appear for the final examinations. Such candidate has to reappear for the MSE as and when the respective examinations are conducted only after getting permission from the Dean, Faculty of Marine Sciences on payment of fee prescribed by the University. MSE will be conducted by the Dean, Faculty of Marine Sciences. The answer scripts will be shown to the student after valuation, and

returned to the course teacher. The paper in-charge will be responsible to ensure the distribution of answer papers to the students.

10.2 MSE marks awarded in a course will be added to the supplementary examinations also.

10.3. The MSE marks will be furnished to the Dean, Faculty of Marine Sciences through Course in-charge within 10 days after the conduct of MSE. If the student is not satisfied with the award of the marks, he/she shall appeal to the Dean, within three working days after the announcement of marks. The appeal will be considered and the results reviewed by a Cell consisting of the Dean and the Course in-charge concerned. The decision of the Review Cell shall be final. If the Course in-charge himself is the course teacher, one senior member of the department concerned shall be nominated by the Dean.

10.4. The MSE of theory will be two hours duration

For courses with both theory and practical, 20 marks will be apportioned as shown below.

	Marks
i) Multiple choice questions @ 1 marks For 15 questions	15
ii) Match the following @ ½ marks For 10 questions	5
iii) Short answer @ 6 marks for 10 questions out of 15	60
Total	<hr style="width: 50%; margin-left: auto; margin-right: 0;"/> 80 <hr style="width: 50%; margin-left: auto; margin-right: 0;"/>

The above total marks of 80 to be converted into 20 marks will be apportioned

10.5. If the student is not able to write the MSE due to deputation by the University he / she may be permitted to take up missing MSE. Such examination should be completed ordinarily within 15 working days after the respective MSE.

10.6. A student who fails to attend a mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the Dean to take up missing examination of the particulars course, on

payment of fee prescribed by the University. Such tests should be completed ordinarily within 15 working days after the respective MSE.

11. Final examination

11.1 The final theory and practical examinations will be of two and three hour's duration respectively.

11.2 Theory examinations will be conducted after practical examinations.

11.3 The question papers for the final theory examinations will be set by the external examiners.

The 80 marks will be apportioned as shown below

i) Multiple choice questions @ 1 marks For 15 questions	15
ii) Match the following @ ½ marks For 10 questions	5
iii) Short answer @ 6 marks for 10 questions out of 15	60
	<u>Total 80</u>
	———

11.4. Central valuation of answer books will be done by examiners on the advice of the Chairman, Board of Examiners.

11.5. Practical Examination

Practical examinations will be conducted separately towards the end of each semester. Proper maintenance and regular submission of practical records are required. Those who do not bring with them the certified practical records will not be allowed to appear for the practical examination. The marks awarded for assignments shall be noted in the record, at the time of first appearance and will be taken in to account for subsequent appearances. Such marks awarded by the examiner will be furnished to the Head of the Department.

11.6. Two examiners appointed by the University, nominated by Head of the Department and recommended by the Dean will conduct the practical examination.

12.Re-appearance and improvement examination

12.1 Re-appearance and improvement examinations are permitted only for the final theory and practical examinations (retaining marks obtained in mid- semester examination) at the time of regular semester examination only, after the payment of fee prescribed by the University. A student is permitted to write reappearance examination for the failed subjects only three times during n+4 years duration excluding the regular final examination. In the event of a student failing to secure a pass in the three re-examinations permitted, he/she has to reregister the course along with juniors

12.2 A students who failed in a course (subject) or awarded EE can take up re – examination without undergoing regular classes. A student who has not fulfilled attendance requirement should repeat the course to earn attendance before he/she is permitted to proceed to the next semester.

12.3. The student having an OGPA of more than 5.00 only is eligible to improve the grade point only once in courses completed earlier in which he/had obtained grade point of less than 7.99. In case a student fails to secure higher grade point in the subsequent attempts, the higher grade point secured by the student either in regular or improvement examination will be accounted.

Improvement and re-examination will not be allowed in courses with only practical and those who fail in these subjects shall have to repeat the course in the subsequent year/ years.

12.4. Those who miss the study tours for any valid reason must undertake the tour along with juniors to complete the degree Programme.

12.5. A continuing candidate cannot appear for more than six subjects in the reappearance examination at a time. The candidate who has completed the tenure of four years in the B.F.Sc. Degree Programme cannot appear for more than 16 subjects in the reappearance examination at a time.

12.6. The candidates for the reappearance examinations will submit their applications through the Dean, Faculty of Marine Sciences who will scrutinize the applications to ensure compliance of regulation

The attested copy of all grade sheets pertaining to the reappearance examinations should be enclosed along with the applications.

13. Malpractices in examinations

13.1. The Dean, Faculty of Marine Science shall be responsible for dealing all cases of unfair means by students in writing records, assignments and examinations.

13.2. The invigilator or the course teacher concerned shall report each case of unfair means with full details of the evidence and written explanation of the student concerned to the Dean immediately.

13.3 The Dean shall take appropriate steps on receipt of the report and the report will be sent to the Controller of Examinations for appropriate action as prescribed by the University.

14. Regulations of students conduct and discipline

14.1 Ragging Rules:

Students found involved in ragging or in any other misconduct, or if a complaint is received from the affected student(s) to that effect, will be immediately expelled from the current semester and the Dean shall further constitute a committee to probe and conduct enquiry into the matter and based on the report of the committee, the Dean shall forward the same to the Registrar to pass the final orders on merit of case within three working days.

14.2. Unlawful Activities:

In case of students found involved in any unlawful activities either within or outside the Hostel/ College Campus, besides expulsion both from the Hostel and College, at the discretion of the Dean with the knowledge of the Registrar, the matter will be reported

to the Police of the jurisdiction to be dealt with in accordance with the appropriate law in force.

14.3. Ragging – An offence

Extract of Tamil Nadu Government Gazette - Extra ordinary dt. 29.01.1997 (Tamil Nadu Prohibition of Ragging Act, 1997)

In this act, unless the context otherwise requires, “Ragging means display of noisy, disorderly conduct, doing any act which causes or is likely to cause physical or psychological harm or raises apprehension or fear or shame or embarrassment to a student in any educational Institution and includes: teasing, abusing or playing practical jokes on or causing hurt to such student or asking the student to do any act or perform something which such student will not, in the ordinary course willingly act or perform. Ragging within or outside any educational institution is prohibited. Whoever directly or indirectly commits, participates in, abets or propagate “Ragging” within or outside any educational institution, shall be punished with imprisonment for a term which may extend to two years and shall also be liable to fine which may extend to ten thousand rupees.

Any student convicted of an offence under section 4 shall also be dismissed from the educational institution and such students shall not be admitted in any other educational institution.

Without prejudice to the foregoing provision, whenever any students complains of ragging to the head of an educational institution, or to any other person responsible for the management of the educational institution, such head of the educational institution or person responsible for the management of the educational institution shall inquire in to the same immediately and if found true shall suspend the students who has committed to offence from the educational institution.

On the recommendation of the Dean, Faculty of Marine Sciences, The Registrar will have full powers to punish any student who violates the rules by imposing a fine, suspension or expulsion for the punishment awarded.

These rules will be altered or amended, and further rules may be added if necessary. All the rules for the time being in force should be observed by the students.

15.Award of Degree

The degree namely (B.F.Sc) shall be awarded during convocation under the seal of the University to the students who have successfully completed all the graduation requirement as detailed below.

The candidates should have undergo successfully the prescribed course of study in the University. They shall further be required to have completed and passed 182 course credits and shall have earned an overall grade point average (OGPA) of 5.50 out of 10 for all courses completed in B.F.Sc degree Programme. In addition to the above, students shall in the judgment of the Faculty, possess good conduct and character.

The University shall issue Provisional Certificate (PC) to the candidates after having passed all provisional examinations.

15.1Class ranking

In calculation of class equivalent for OGPA the following classification shall be adopted

OGPA	Division / Class
8.00 And above	First with Distinction
7.00 – 7.99	First
6.00 – 6.99	Second
5.00 – 5.99	Pass

16. Transitory Regulations

Separate time table of course work under old semester system will be arranged by the H.D for students with attendance deficiency in a course/courses provided such

course/courses are not currently offered due to the introduction of the revised syllabi with effect from the academic year 2019-2020.

The candidates under old semester system will, however, complete all the examinations within a period of eight academic years from the year of admission.

17. Removal of difficulties

If any difficulty arises in giving effect to the provisions of these regulations based on the recommendations of the Dean, the Vice-Chancellor may issue necessary orders, which appear to him to be necessary or expedient for removing the difficulty.

Outcome of the B.F.Sc. Programme

India has a long coastline of 7,515km spanning from Kanyakumari (Cape comorin) in the South to West Bengal in the North. Of this, Tamilnadu has 1,100 km, encompassing various habitats like estuaries, wetlands, mangroves, coral reefs, etc. harbouring a plethora of marine microbial, floral and faunal diversity, including seaweed, shellfish and finfish resources which have direct and indirect values to humankind.

Knowledge outcomes of B.F.Sc. Programme

Broad Knowledge / skill development in the following areas of Fisheries and Aquaculture sectors, will be imparted

- 1) Limnology and Oceanography
- 2) Modern taxonomy of shell and finfish (Molecular taxonomy)
- 3) Navigation
- 4) Swimming and SCUBA diving techniques
- 5) Crafts and gears used in the fisheries sector.
- 6) Application of statistics for fishery management.

7) Aquarium keeping and ornamental shrimp and finfish culture.

8) Legislations and Acts regarding the coastal regulation zone, Wild Life Protection Act (1974), Biodiversity conservation, clean coastal environment, etc.

9) Socio- economic status, Government support/schemes for developing entrepreneurship.

10) New technology in preservation and processing of sea foods and value addition for marketing.

11) In plant training and fisheries industry interactions for students to create confidence for entrepreneurship.

12) Progression of B.F.Sc. students to PG and the research programmes in various national and international institutions.

I. CURRICULUM

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1. NORMS:

(1) Degree Nomenclature

B.F.Sc.: Bachelor of Fisheries Sciences

(2) System of Education

Formal Education with Semester System

(3) Program Duration

8 Semesters (4 Academic Years)

(4) Maximum Permissible Course Work Load 24 Evaluated Credits per semester

(5) Course Curriculum and Credits Requirement

The total credit requirement for the under- graduate degree programme shall be 182 credits

Subject Code	Semester/Course title	Credit hours
I Semester		
BFSC 101	Principles of Aquaculture	2(1+1)
BFSC 102	Anatomy and Biology of Finfish	3(2+1)
BFSC 103	Taxonomy of Finfish	3(1+2)
BFSC 104	Meteorology, Climatology and Disaster Management	3(2+1)
BFSC 105	Statistical Methods	3(2+1)
BFSC 106	Fundamentals of Biochemistry	3(2+1)
BFSC 107	Fundamentals of Microbiology	3(2+1)
BFSC 108	Soil and Water Chemistry	3(2+1)
BFSC 109	Swimming	1(0+1)
Total		24 (14+10)
II Semester		
BFSC 201	Freshwater Aquaculture	3(2+1)
BFSC 202	Aquaculture in Reservoirs	2(1+1)
BFSC 203	Taxonomy of Shellfish	2(1+1)
BFSC 204	Anatomy and Biology of Shellfish	2(1+1)
BFSC 205	Inland Fisheries	3(2+1)
BFSC 206	Limnology	3(2+1)
BFSC 207	Marine Biology	3(2+1)
BFSC 208	Food Chemistry and Fish in Nutrition	3(2+1)
BFSC 209	Information and Communication Technology	2(1+1)
BFSC 210	Physical Education, First Aid & Yoga Practices	1(0+1)
Total		24 (14+10)
III Semester		
BFSC 301	Ornamental Fish Production and Management	2(1+1)
BFSC 302	Fish Food Organisms	2(1+1)
BFSC 303	Fish Immunology	2(1+1)
BFSC 304	Marine Fisheries	3(2+1)
BFSC 305	Aquatic Ecology and Biodiversity	3(2+1)
BFSC 306	Freezing Technology	2(1+1)
BFSC 307	Refrigeration and Equipment Engineering	3(2+1)
BFSC 308	Fisheries Extension Education and Personality Development	3(2+1)
BFSC 309	Fisheries Economics	3(2+1)
Total		23(14+9)
IV Semester		
BFSC 401	Coastal Aquaculture and Mariculture	3(2+1)
BFSC 402	Genetics and Breeding	2(1+1)
BFSC 403	Fish Nutrition and Feed Technology	3(2+1)

BFSC 404	Fish and Shellfish Pathology	3(2+1)
BFSC 405	Physiology of Finfish and Shellfish	3(2+1)
BFSC 406	Fishery Oceanography	2(1+1)
BFSC 407	Aquatic Pollution and Coastal Zone Management	3(2+1)
BFSC 408	Fish Canning Technology	2(1+1)
BFSC 409	Fishing Gear Technology	2(1+1)
	Total	23(14+9)
V Semester		
BFSC 501	Finfish Hatchery Management	3(2+1)
BFSC 502	Introduction to Biotechnology and Bioinformatics	3(2+1)
BFSC 503	Pharmacology	3(2+1)
BFSC 504	Fish Toxicology	2(1+1)
BFSC 505	Fish Population Dynamics and Stock Assessment	3(2+1)
BFSC 506	Fish By-Products and Waste Utilization	2(1+1)
BFSC 507	Microbiology of Fish and Fishery Products	3(2+1)
BFSC 508	Aquaculture Engineering	3(2+1)
BFSC 509	Fishing Craft Technology	2(1+1)
Total	24(15+9)	
VI Semester		
BFSC 601	Shellfish Hatchery Management	2(1+1)
BFSC 602	Microbial and Parasitic Diseases of Fish and Shellfish	3(2+1)
BFSC 603	Therapeutics in Aquaculture	2(1+1)
BFSC 604	Fish Products and Value Addition	3(2+1)
BFSC 605	Fish Packaging Technology	2(1+1)
BFSC 606	Quality Assurance of Fish and Fishery Products	3(2+1)
BFSC 607	Fishing Technology	2(1+1)
BFSC 608	Navigation and Seamanship	2(1+1)
BFSC 609	Fisheries Administration and Entrepreneurship Development	2(2+0)
BFSC 610	Fisheries Co-Operatives, Marketing and Business Management	3(2+1)
Total	24(15+9)	
VII Semester		
BFSC 701	In-plant attachment (for 8 weeks)	10(0+10)
BFSC 702	Rural Fisheries Work Experience Programme (for 8 weeks)	8(0+8)
BFSC 703	Study Tour (in and outside State) (for 4 weeks)	2(0+2)
	Total	20(0+20)
VIII Semester		
BFSC 801	Skill Development (for one week)	5(0+5)
BFSC 802	Experimental Learning Programme	12(0+12)
BFSC 803	Project work	2(0+2)
BFSC 804	Seminar	1(0+1)
	Total	20(0+20)
Grand Total Credits		182

Programme Outcomes

PO1:	The Faculty of Marine Sciences offers Bachelor of Fishery Science (BFSC) course along with other master program since this faculty is in ideal location covering marine and fresh water based ecosystems besides the expertise in the subject areas. This is being taught with updated and advanced technology, including the recent research in the area of fishery sciences
PO2:	The Faculty will continue to review, update and revise the curriculum to ensure the quality of syllabus in accordance with ICAR regulation and guidelines
PO3:	Students will be made fully skilled in Bachelor of Fishery Science (BFSC) with respect to aquaculture, fisheries management, formulating policies and making crucial developments in fisheries sector/ fishing community
PO4:	Students graduating in Bachelor of Fishery Science (BFSC) will be motivated for higher studies and involved in research program and will be trained to achieve in competitive exams and will be trained to become entrepreneurship and make use of government and non-government job opportunities.

Programme Specific Outcomes

At the end of the program, the students will be able to

O1:	The students will be able to learn about the basics of Taxonomy of fresh water and marine water fishes starting from lower trophic level organisms to higher trophic level organisms. Also will be able select the species which are feasible for fresh water brackish water and coastal water aquaculture
O2:	Gain the knowledge about the taxonomy of marine organisms by using the conventional method and advanced level of molecular methods and characteristic features of soil and water quality
O3:	The biology of aquatic organisms will be fully understood by the students and capable of distinguishing the biology of each group of organisms and the statistical approach of fishery science will be applied
O4:	The importance of microbes in the environment and their specific role in the ecosystem; classification will be understood and application of information technology in fishery science will be illustrated
O5:	The knowledge on finfish and shell fish taxonomy will be imbibed to the students and all features of limnology and marine biology will also be imparted
O6:	The basic principles of nutritional biology in finfish and shellfish will be gained by

	the students and the biochemical aspects of essential proximate composition will also be imparted
07:	The efficacy and proper use of culture of marine and fresh water organisms, utilization of marine resources to make as an entrepreneur and national & international level researcher. Aquaculture practice will be taught with structural and mechanical engineering etc.

SYLLABUS

FIRST SEMESTER

BFSC 101 PRINCIPLES OF AQUACULTURE 2 (1+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To learn the basic concept of Aquaculture their use in the fisheries, International scenario and the importance of fresh water and coastal aquaculture

LO2: To familiarize with Aquaculture farming and systematic approach Extensive, semi-intensive, intensive and super intensive aquaculture

LO3: To learn the techniques-pre-stocking and post stocking pond management, carrying capacity of pond, factors influencing carrying capacity. Criteria for selection of candidate species for aquaculture

LO4: To understand the water and soil quality in relation to fish production, physical, chemical and biological factors affecting productivity of ponds

LO5: To learn the practical knowledge of aquaculture practices on pre-stocking and post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH₃, Organic matter, CO₂). Analysis of manure

THEORY

Unit - I

Basics of aquaculture, definition and scope. History of aquaculture: Present global and national scenario. Aquaculture vs Agriculture

Unit - II

Systems of aquaculture - pond culture, pen culture, cage culture, running water culture and zero water exchange system

Unit - III

Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water

Unit - IV

Principles of organic aquaculture. Pre-stocking and post stocking pond management. Carrying capacity of pond, factors influencing carrying capacity. Criteria for selection of candidate species for aquaculture

Unit - V

Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integrated culture systems. Water and soil quality in relation to fish production. Physical, chemical and biological factors affecting productivity of ponds.

PRACTICALS

Aquaculture production statistics- world and India. Aquaculture resources of world and India. Components of Aquaculture farms. Estimation of carrying capacity. Practices on pre-stocking and post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH₃, Organic matter, CO₂). Analysis of manure.

TEXT BOOKS

1. Jhingaran, V.G., 1991. *Fish and Fisheries of India*. Hindustan Publ. Corp.
2. Mathias, J.S., A.T. Charles and H.U. Bootong, 1998. *Integrated fish farming*, 470 pp, CRC publishers.
3. Rath, R.K., 2000. *Freshwater Aquaculture*. Scientific Publ.
4. Pillay, T.V.R. and M.N. Kutty, 2005. *Aquaculture: Principles and Practices*. 2nd Ed. Blackwell.
5. Dubey, S.K., 2006. *Fish Farming*. Dominant Publ.
6. Pandey, N. and S.M. Davendra, 2008. *Integrated Fish Farming*. Daya Publ. House.

REFERENCE BOOKS

1. Sinha, V.R.P. and V. Ramachandran, 1985. *Freshwater Fish Culture*. ICAR.
2. Shepherd, J. and N. Brommage, 1990. *Intensive Fish Farming*. B.S.P. Professional Books.
3. Selvamani, B.R. and R.K. Mahadevan, 2008. *Fish Farming Systems*. Campus Books International.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The basic concept of Aquaculture their use in the fisheries, International scenario and the history of aquaculture will be fully learnt by the students

CO2: The systematic approach of aquaculture farming and systematic approach extensive, semi-intensive, intensive and super intensive aquaculture will be known to the students

CO3: The students will be benefited with the techniques involved in selection of quality seeds and transportation technique of fish seeds and pre-stocking and post stocking pond management, carrying capacity of pond, factors influencing carrying capacity

CO4: Students will be fully made aware water and soil quality in relation to fish production, physical, chemical and biological factors affecting productivity of ponds

CO5: Students will learn the practical knowledge of aquaculture practices Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH₃, Organic matter, CO₂). Analysis of manure etc

Outcome Mapping

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

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

BFSC-102 ANATOMY AND BIOLOGY OF FINFISH 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

L01: To learn the external anatomy and internal anatomy and its associated glands and cell

structure of important groups of finfishes

LO2: To understand the gut content, circulatory, respiratory, nervous, skeletal and sensory organs and reproductive sexual dimorphism- maturity stages, eggs and larval stages and developmental biology of fin fishes

LO3: To learn the practical knowledge on dissection of fin fishes to understand their internal organs, digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs and structure of endocrine glands – different developmental stages and tagging marking methods

THEORY

Unit – I

Study of external and internal anatomy of important groups of finfish. Study of oral region and associated structures. digestive system and associated digestive glands presents

Unit – II

Food and feeding habits of commercially important fishes- qualitative and quantitative methods of analysis of gut contents.

Unit – III

Circulatory system, respiratory system, nervous system, endocrine system, skeletal systems and sensory organs

Unit – IV

Urino-genital system- Reproductive biology Sexual dimorphism- maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology.

Unit – V

Age and growth determination by direct and indirect methods. fish migration type and significance. Tagging and marking.

PRACTICALS

Study of internal organs digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. Study of food and feeding habits. Analysis of gut contents. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The students will be able to learn the external anatomy and internal anatomy and its associated glands and cell structure of finfishes and shellfishes

CO2: Students can also understand the circulatory, respiratory, nervous and reproductive system of selected finfishes on sexual dimorphism- maturity stages, eggs and larval stages and developmental biology of fin fishes

CO3: The practical knowledge on dissection of different shellfishes and finfishes to understand their internal organs, digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs and structure of endocrine glands – different developmental stages and tagging marking methods will be fully practiced for achieving the target

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3		3	3		3	
CO2	3		3	3		3	3
CO3	3		3	3	3	3	3
Total	9	-	9	9	3	9	6

BFSC-103 TAXONOMY OF FINFISH 3 (1+2)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives:

L01: To learn the basic and fundamentals of system of Taxonomy and its importance

L02: To become expertise in identification of fishes meristic and morphometric

characteristics for identification of species

L03: To acquire knowledge on usage of modern tools in identification of fishes

L04: To learn the commercially important fishes of India and other countries

L05: To learn practical knowledge on conventional and modern techniques in taxonomical studies of fishes

THEORY

Unit - I

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification.

Unit - II

Morphological, morphometric and meristic characteristics of taxonomic significance.

Unit - III

Major taxa of inland and marine fishes up to family level.

Unit - IV

Commercially important freshwater and marine fishes of India and their morphological characteristics.

Unit - V

Introduction to modern taxonomic tools: karyotaxonomy, DNA barcoding, protein analysis and DNA polymorphism.

PRACTICALS

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Visit to fish landing centers to study commercially important fishes and catch composition.

TEXT BOOKS

1. Nelson, J.S, 2006. Fishes of the World, 4th edition, John Wiley & Sons, Inc., Hoboken, New Jersey, USA, 601 pp
2. Bore, Q. and Richard H. Moore, 2008. Biology of fishes, 3rd edition, Taylor and Francis Groups, New York, 478 pp.

REFERENCE BOOKS

1. Mayer, E., 1977. Principle of Systematic Zoology. Tata McGraw Hill.
2. Whitmore, D.H., 1990. Electrophoretic and Isoelectric Focusing Techniques in Fisheries Management. CRC Press.

3. Kocher, T.D. and A.S. Carol (Ed.), 1997. Molecular Systematics of Fishes. Academic Press.
4. Ponniah, A.G. and J. George, 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.
5. FAO, 2000. DNA Based Molecular Diagnostic Techniques.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The importance of Taxonomy and its application for future research and its importance will be thoroughly understood

CO2: The students will be made expertise in identification of marine and fresh water fishes using traditional/conventional methods

CO3: The students will gain the knowledge on usage of modern tools in identification of fishes

CO4: The commercially important fishes of India and other countries will be categorised and their economical values will be known

CO5: The students will be imbibed with practical knowledge on conventional and modern techniques in taxonomical studies of fishes

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3			3		3

CO2	3	3	3		3	3	
CO3	3	3	3		3		
CO4	3	3					3
CO5	3	3	3		3		
Total	15	15	9		12	3	6

BFSC-104 METEOROLOGY, CLIMATOLOGY AND DISASTER MANAGEMENT 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives:

- L01:** To learn the basic and fundamentals of nature of atmosphere and its importance and factors influencing / affecting the weather and learn about temperature, pressure, density humidity and various meteorological instruments
- L02:** To become expertise in understanding the cloud pattern, laws of atmospheric gases, pressure gradients, planetary wind system including coriolis forces etc
- L03:** To acquire knowledge on weather forecasting, cyclone warning, precipitation, thunderstorms, large atmospheric cycles, concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape etc
- L04:** To learn the manmade hazards in coastal hazards, disaster management- cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc
- L05:** To learn practical knowledge on weather and meteorological instruments (Thermoneter, Barometer, Hygrometer Anemometer, Rain gauge) and Condensation: observation and identification of various types of clouds and depicting sky picture

THEORY

Unit - I

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: process of heat transmission; heating of atmosphere; disposal of insolation; irregular heating of atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature

variations; effects of vertical air motion on temperature. Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India.

Unit - II

Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms. Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients. Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze.

Unit - III

Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning. Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Effects of climate change on fisheries sector. Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape.

Unit - IV

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters.

Unit - V

Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. Post-disaster: Methods for assessment of initial and

long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global levels. Sea safety and health. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counselling

PRACTICALS

Meteorology: Graphic representation of structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; six Max-Min Thermometer; thermograph. Isotherms: world mean temperatures-January to July. India mean temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets. Atmospheric pressure measurement: Fortins mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Typical landscape mapping; map reading. Geographical terms used in landscape

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The fundamentals of nature of atmosphere and its importance and factors influencing /affecting the weather and learn about temperature, pressure, density humidity and various meteorological instruments will be thoroughly understood

CO2: The students will be made expertise in understanding the cloud pattern, laws of atmospheric gases, pressure gradients, planetary wind system including coriolis forces etc

CO3: The students will gain the knowledge on weather forecasting cyclone warning precipitation, thunder storms, large atmospheric cycles, concepts of latitude, longitude and great circles; model globe, maps and different types of projections

CO4: Manmade hazards in in coastal hazards, disaster management - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity will be known to the student community

CO5: The students will be imbued with practical knowledge on weather and meteorological instruments (Thermometer, Barometer, Hygrometer Anemometer, Rain gauge) and Condensation: observation and identification of various types of clouds and depicting sky picture

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		3		3			3
CO2		3		3			
CO3		3					3
CO4		3					
CO5							3
Total		12		6			9

BFSC-105 STATISTICAL METHODS 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To study the basic concept of statistics to understand the population dynamics and how to carry out this study and merits and demerits and different diagrammatic representation of statistics etc

LO2: To familiarise with multivariate analysis, principal component analysis, cluster,

dendrogram, histogram etc and to know the central tendency - arithmetic mean median and mode. Relative merits and demerits of these measures. Important measures of dispersion, Range, Mean Deviation, Variance and Standard Deviation

L03: To learn the techniques involved statistical analysis regression, binomial, Poisson and Normal distributions and their use in fisheries arithmetic calculations mean, mode deviation etc.

L04: To understand the T test merits and demerits, Chi-square linear non-linear correlation; length-weight relationship bivariate methods etc

L05: To learn the practical knowledge of fisheries data such as T test of hypothesis based on normal, t, chi-square and F distributions and test of hypothesis based on normal, t, and chi-square simple problems. Fitting of length-weight relationship in fishes etc

THEORY

Unit - I

Definition of statistics, Concepts of population, sample, Census and sample surveys, Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogives

Unit - II

Important measures of central tendency - arithmetic mean median and mode. Relative merits and demerits of these measures. Important measures of dispersion, Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis.

Unit - III

Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries.

Unit - IV

Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions.

Unit - V

Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression, Length weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

PRACTICALS

Construction of questionnaires and schedules. Diagrams and frequency graphs, calculation of arithmetic mean, median, mode, range, mean deviation, variance and standard deviation. Exercises on probability and conditional probability, Binomial and Poisson distributions, Area of normal curve. Test of hypothesis based on normal, t, and chi-square simple problems. Simple Problems on correlation and regression. Fitting of length-weight relationship in fishes.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

- CO1:** The basic concept of statistics to understand the population dynamics and how to carry out the study using field generated data? Internal data and merits and demerits will be understood by the students
- CO2:** The students will be familiarised with multivariate analysis, principal component analysis, cluster analysis, dendrogram/histogram etc
- CO3:** The techniques of statistical analysis regression, arithmetic calculations mean, mode deviation etc will be thoroughly known by the students
- CO4:** Understand the T test and its merits and demerits is very important in statistics and Chi-square linear non-linear correlation; length-weight relationship; bivariate methods will be illustrated to the students
- CO5:** The practical knowledge of fisheries data such as T test of hypothesis based on normal, t, chi-square and F distributions will be taught. The students will also be familiarized with recent statistical packages

Outcome Mapping

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

CO 2	3				3	3			3		
CO 3	3				2	2					
CO 4	3				3	3					
CO 5	3	3			2	2					

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3			3		
CO2	3	3			3		
CO3	2	2					
CO4	3	3					
CO5	2	2					
Total	13	13			6		

BFSC-106 FUNDAMENTALS OF BIOCHEMISTRY 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

L01: To know the concept of biochemistry, molecular biology, proteomics and nutritional

biology and to know the role of enzymes in biochemistry

LO2: To gather knowledge on protein and basic amino acids; lipid and their basic units and carbohydrates and their classification and basic and functional properties and their cycle in biochemical aspects and importance of fatty acids and to know biochemical techniques, chromatography, electrophoresis etc

LO3: To learn the practical knowledge on assessment of proximate composition and all the laboratory techniques, Qualitative determination of carbohydrates, proteins and lipids and free fatty acid etc and DNA, RNA isolation and estimation using advanced techniques

THEORY

Unit – I

A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life.

Unit – II

Protein chemistry: classifications and functions. Classification, structure, function and properties of amino acids. Essential and non essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins. Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity

Unit – III

Carbohydrate chemistry: Structure, classification, functions (mono, di and polysaccharides) isomerism and mutarotation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Digestion and absorption of lipids. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids.

Unit – IV

Structure and functions of fat and water soluble vitamins. Vitamins classification-functions. Minerals classification functions. Steroid and peptide hormones- chemistry and function. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Protein synthesis. Energy changes in chemical reactions, reversible and irreversible reactions in metabolism.

Unit – V

Biochemical Techniques: Chromatography Partition coefficient, Retention, Resolution, Capacity factor, theoretical plate, Van Deemter curve, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Hydrophobic interaction chromatography, Paper chromatography, Thin layer chromatography, Reversed-phase chromatography, Fundamentals of high performance chromatography Electrophoresis Native PAGE, SDS-PAGE, Isoelectric focusing, 2D-PAGE, Capillary electrophoresis Spectroscopy: Fundamentals of UV Spectroscopy, Spectrophotometer, Fundamentals of fluorescence spectroscopy, Spectrofluorometer.

PRACTICALS

Preparation of normal solution of acid and base, buffers and reagents. Qualitative determination of carbohydrates, proteins and lipids. Estimation of total nitrogen and crude protein of fish tissue. Estimation of carbohydrates in foods .Determination of specific gravity of oil. Extraction and estimation of total lipids in fish tissue. Determination of saponification value, iodine value and free fatty acid value.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: Students will be able to know the concept of biochemistry, major nutrition, and different role of the nutrients in the animal body and their metabolism etc

CO2: Students will gather the knowledge on protein and basic amino acids; lipid and their basic units and carbohydrates and their classification and basic and functional properties.

CO3: The students will be fully trained on assessment of proximate composition and all the laboratory techniques, DNA, RNA isolation and estimation using advanced techniques

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
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CO1			3		3		2
CO2			3		3		
CO3			3		3		2
Total			9		9		4

BFSC-107 FUNDAMENTALS OF MICROBIOLOGY 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives:

- LO1:** To study the background aspects of taxonomy microbes which include bacteria, fungi, virus, unicellular algae and protozoa etc and difference between Prokaryotic and eukaryotic etc
- LO2:** To familiarise the use of different kinds of microscopes for elaborate study of microbial organisms
- LO3:** To learn the techniques involved in microbial culture and identification of microbes using different methods
- LO4:** To understand the role of microbes in biochemical process and their role in nutrient cycle in the ecosystem. The microbial diseases and their control measures
- LO5:** To learn the practical knowledge of microbial isolation from the environment and enumeration/identification. Genetic and biochemical aspects

THEORY

Unit - I

Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogradsky. Microbial taxonomy Bergy's and molecular taxonomy Types of Microorganisms: Prokaryotes Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes Diagnostic features and importance of fungi and protozoa.

Unit - II

Microscopy- Principle and construction of bright field, dark field, phase contrast, stereo, SEM and TEM. Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques simple, differential, structural staining; enumeration of micro-organisms, culture preservation methods.

Unit - III

Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids- types and their importance. Mutation types and significance.

Unit - IV

Microbial ecology: Introduction and types of interaction, extremophiles and their significance Aquatic Microbiology: Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses; distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms.

Unit - V

Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators. Economic significance of aquatic microbes.

PRACTICALS

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae*, *Vibrio parahaemolyticus*, *E. coli*, *Salmonella*, *Listeria monocytogenes* and faecal streptococci. Biochemical tests for characterization of bacteria.

Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

TEXTBOOKS

1. Frobisher, M., R.D.Hinsdill, K.T. Crabtree and C.R. Goodheart, 1974. Fundamentals of Microbiology. WB Saunders.
2. Rheinheimer, G., 1992. Aquatic Microbiology. John Wiley & Sons.
3. Geesey, G., Z. Lewandowski and H.C. Flemming (Eds.), 1994. Biofouling and Biocorrosion in Industrial Water Systems. CRC Press.
4. Dhevendaran, K., 2008. Aquatic Microbiology. Daya Publ. House.

REFERENCE BOOKS

1. Stanier, R., J.L .Ingraham and E.A. Adelberg, 1976. General Microbiology. MacMillan
2. Prasad, A.B.and A. Vaishampayan, 1994. Nitrogen Fixing Organisms – Problems and Prospects. Scientific Publ.
3. Vernam, A.H.and M.Evans, 2000. Environmental Microbiology. Blackwell.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

- CO1:** The ecosystem and taxonomy of microbes will be understood by the students along with prokaryotic and eukaryotic divisions
- CO2:** Hands on techniques on handling the microscopes in the class and instrumentation lab will be elaborate study of microbial organisms
- CO3:** Screening, isolation and enumeration of microbes using different media and application of advanced techniques for easy and speedy identification will be known
- CO4:** Understand the role of microbes in biochemical process and their role in nutrient cycle in the ecosystem will be acquainted to the students and the microbial diseases and their control measures will be understood
- CO5:** The practical knowledge of microbial isolation from the environment and enumeration/identification. Genetic and biochemical aspects will be achieved by the students

Outcome Mapping

CO/ PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3			3	2	3		3			
CO2	3			3	3	3		3			

CO3	3							3			
CO4	3			3				3		3	
CO5				3				3		3	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3		3			
CO2	3	3		3			
CO3				3			
CO4				3		3	
CO5				3		3	
Total	5	6		15		6	

BFSC-108 SOIL AND WATER CHEMISTRY 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

- LO1:** To learn the analytical chemistry in which the titrimetric, gravimetric and volumetric methods
- LO2:** To familiarize with sea water quality analysis in terms of physico-chemical parameters and nutrients and dissolved gases and their importance
- LO3:** To learn the soil chemistry with texture and minerals in the soil and assess the soil quality and soil types and their distribution
- LO4:** To understand the methods involved in soil quality analysis including minerals and organic carbon and oxidation and reduction processes etc
- LO5:** To learn the practical knowledge of analytical techniques for water and soil quality

THEORY

Unit - I

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve; nomograph.

Unit - II

Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Dissolved gasses: Factors affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer.

Water analysis: collection and preservation of water samples. Measurement of temperature, transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

Unit - III

Soil Chemistry: origin and nature of soils. Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential.

Unit - IV

Submerged soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soil samples. Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement.

Unit - V

Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

PRACTICALS

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis. Water analysis: measurement of temperature, turbidity, determination of pH and EC. Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO₂. Determination of total alkalinity, hardness. Determination of inorganic nitrogen, and phosphorus Soil analysis: Determination of soil

texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.

TEXT BOOKS

1. Parsons, T.R., Y. Maita and C.M.Lalli, 1984. A Manual of Chemical and Biological Methods for Seawater Analysis. Pergamon Press.
2. APHA, AWWA, WPCF, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D. C.
3. Rajagopalsamy, C.B.T. and V. Ramadhas, 2002. Nutrient Dynamics in Freshwater Fish Culture System. Daya Publ.
4. ICAR, 2006. Handbook of Fisheries and Aquaculture. ICAR.
5. Adhikari, S. and D.K.Chatterjee, 2008. Management of Tropical Freshwater Ponds. Daya Publ.
6. Sharma, L.L., S.K. Sharma, V.P. Saini and B.K.Sharma (Eds.), 2008. Management of Freshwater Ecosystems. Agrotech Publ. Academy.

REFERENCE BOOKS

1. Boyd, C.E., 1982. Water Quality management for pond fish culture. Elsevier Sci. Publishers.
2. Boyd, C. E. and Tucker, C. S., 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The students will be made familiarized with the analytical chemistry in which the Titrimetric, gravimetric and volumetric methods

CO2: Students will also be enabled to learn and understand the water quality analysis and their importance

CO3: The soil chemistry with texture and minerals in the soil and assess the soil quality and soil types and their distribution will be understood by the students

CO4: The methods involved in soil quality analysis including texture, minerals and organic carbon will be taught to the students

CO5: The students will also learn the practical knowledge of analytical techniques all aspects of water and soil quality analysis

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		3	3	3			
CO2	3	3		3			
CO3	2	3		3			
CO4		3		3			
CO5	2	3		2			
Total	7	15	3	14			

BFSC-109* SWIMMING 1 (0+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To learn the swimming techniques and to understand the practice of ducking the head, kicking action, holding breath under water and various strokes

LO2: To familiarize with the methods of life saving in water; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulations and practice.

PRACTICALS

History, hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke); competitive swimming-relays and medleys, lap time practice, swimming and floating aids and their uses; diving - styles of diving, rules, regulations and precautions. Methods of life saving in water; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulations and practice.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The students will be made familiarize with the swimming art including scuba diving etc. of all aspects swimming techniques

CO2: Students will also be enabling to learn the techniques of swimming and skill development, rules and regulations and practice.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1							3
CO2							
Total							3

SECOND SEMESTER

BFSC 201- FRESHWATER AQUACULTURE 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

L01: To learn the basic concept of fresh water aquaculture their use in the fisheries, International scenario and the importance of fresh water and coastal aquaculture

L02: To familiarize with fresh water aquaculture farming and systematic approach if farming soil quality management and fertilizers application and water cultivation technique

L03: To learn the techniques involved in selection of quality seeds and transportation technique of fish seeds and important steps to identify the cultivable fish and shellfish

L04: To understand the culture methods of Indian fresh water prawn major carps, Exotic carps, Minor carps etc

L05: To learn the practical knowledge of aquaculture pond preparation, nursery techniques and rearing techniques and primary production etc

THEORY

Unit - I

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc.

Unit - II

Nursery, rearing and grow-out ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management.

Unit - III

Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods-Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels.

Unit - IV

Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture.

Unit - V

Composite fish culture system of Indian and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfish and murrels. Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

PRACTICALS

Preparation and management of nursery, rearing and grow-out ponds. Study on effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Workout of economics of different culture practices. Estimation of live stock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

- CO1:** The basic concept of fresh water aquaculture their use in the fisheries, International scenario and the importance of fresh water and coastal aquaculture will fully learnt by the students
- CO2:** The fresh water aquaculture farming and systematic approach if farming soil quality management and fertilizers application and water cultivation technique will be taught to the students
- CO3:** The students will be benefited with the techniques involved in selection of quality seeds and transportation technique of fish seeds and important steps to identify the cultivable fish and shellfish
- CO4:** Students will be fully made aware of the culture methods of Indian fresh water prawn major carps, Exotic carps, Minor carps etc
- CO5:** Students will learn the practical knowledge of aquaculture pond preparation, nursery techniques and rearing techniques and primary production etc

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3			2			3
CO2	3						3
CO3	3						3
CO4	3						
CO5	3						
Total	15			2			9

BFSC 202 AQUACULTURE IN RESERVOIRS 2 (1+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

L01: To learn the basic concept of reservoirs, topography and species diversity, importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production

L02: To familiarize with salient features of reservoirs and recent advances in reservoirs

fisheries management; conservation measures in reservoir fisheries

L03: To learn the techniques involved in cage and pen culture and fish stocking reservoirs

L04: To understand the culture methods of suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture

L05: To learn the practical knowledge on reservoir aquaculture and case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation

THEORY

Unit - I

Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and post-impoundment stages and their significance in establishment of reservoirs fisheries.

Unit - II

Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production.

Unit - III

Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs

Unit - IV

Role of cage and pen culture in enhancement of fish production from reservoirs; history of cage culture, advantages of cage culture; selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system. Integration of cage culture with other farming systems.

Unit - V

History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture.

PRACTICALS

Preparation of charts on the present situation of reservoirs fisheries productivity; detailed case studies of selected reservoirs on the changing trends in capture fisheries profile; drawing inferences from the analysis of data; suggestions for the sustainable

development of reservoirs fisheries. Case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The basic concept of reservoirs, topography and species diversity, importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production will be learnt by the students

CO2: The salient features of reservoirs and recent advances in reservoirs fisheries management conservation measures in reservoir fisheries will be taught to the students

CO3: The students will be benefited with the techniques involved in cage and pen culture and fish stocking reservoirs

CO4: Students will learn the practical knowledge on reservoir aquaculture and case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
--	------	------	------	------	------	------	------

CO1	2			3	3		2
CO2	3			3	3		3
CO3	3						3
CO4	3			3			3
Total	11			9	6		11

BFSC-203 TAXONOMY OF SHELLFISH 2 (1+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To learn the morphology and meristic characteristics features of shellfishes

LO2: To understand the major taxa and commercially important shell fishes

LO3: To learn the knowledge of identification of shellfishes using morphology, and meristic characters Field visits for collection of commercially important shellfishes

THEORY

Unit - I

Study of external morphology and meristic characteristics of crustacean and mollusca.

Unit - II

Major taxa of inland and marine crustaceans up to family level.

Unit - III

Major taxa of inland and marine molluscan up to family level.

Unit - IV

Classification of commercially important crustaceans species of India.

Unit - V

Classification of Commercially important molluscan species of India.

PRACTICALS

Study of external morphology. Collection and preservation of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats. Field visits for collection of commercially important shellfishes. Identification of important crustaceans and molluscs.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: Students will be able to learn the morphology and meristic characteristics features of shellfishes

CO2: The classification of fishes, molluscs and crustaceans will be understood and commercially important shell fishes

CO3: The students will learn the knowledge of identification of shellfishes using morphology, and meristic characters and apply for their taxonomical studies

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2		3		
CO2	3		3		3		

CO3	3						
Total	9	3	5		6		

BFSC-204 ANATOMY AND BIOLOGY OF SHELLFISH 2 (1+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To learn the external anatomy and internal anatomy and its associated glands and cell structure of shellfishes

LO2: To understand the age and growth and circulatory, respiratory, nervous and reproductive system of selected shell fishes

LO3: To learn the practical knowledge on dissection of different shellfishes to understand their internal organs, digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs and structure of endocrine glands

THEORY

Unit – I

Study of external and internal organization of commercially important crustaceans and mollusks.

Unit – II

Digestive, respiratory, circulatory, nervous and reproductive systems

Unit – III

Food and feeding habits , length weight relationship.

Unit – IV

Age and growth determination by direct and indirect methods.

Unit – V

Growth, moulting, Reproductive biology, larval stages.

PRACTICALS

Study of Internal Organs commercially important crustaceans and mollusks. Study of Digestive, respiratory, circulatory, nervous and reproductive systems. Study of food and feeding habits - analysis of gut contents, age and growth, length - weight relationship and condition. Reproductive biology: maturity stages, spawning periodicity, fecundity and larval stages.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The students will be able to learn the external anatomy and internal anatomy and its associated glands and cell structure of shellfishes

CO2: Students can also understand the age and growth and circulatory, respiratory, nervous and reproductive system of selected finishes and shell fishes and their importance

CO3: The practical knowledge on dissection of different shellfishes to understand their internal organs, digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs and structure of endocrine glands will be taught to the students and students will be fully practiced

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1			3		2		
CO2	2		3				
CO3	3				3		
Total	5		6		5		

BFSC-205 INLAND FISHERIES 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To learn the freshwater fishery regions of the world and their major fish species composition and global inland fish production data

LO2: To understand the estimation of inland fish catch data and fishing crafts and gears and minor major riverine and estuarine and brackish water system

LO3: To learn the practical knowledge on commercially important groups and observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters etc.

THEORY

Unit - I

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India.

Unit - II

Potential of inland water bodies with reference to respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears.

Unit - III

Major riverine and estuarine systems of India.

Unit - IV

Major brackish water lakes and their fisheries. Flood-plain capture fishery- present status of their exploitation and future prospects

Unit - V

Fisheries of major reservoirs / natural lakes of India. Cold water fisheries of India.

PRACTICALS

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, net making yards.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The students will be able to learn inland fisheries and freshwater fishery regions of the world and their major fish species composition and global inland fish production data

CO2: Students can also understand the estimation of inland fish catch data and fishing crafts and gears and minor major riverine and estuarine and brackish water system

CO3: The practical knowledge on commercially important groups and observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters etc.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3			2			3
CO2	3		3				3
CO3	3						
Total	9		3	2			6

BFSC-206 LIMNOLOGY 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To gather basic concept of Limnology and origin and evolution of fresh water on the earth

LO2: To understand the physical properties of fresh water in different habitat and their quality such as dissolved gases, carbonate and bicarbonates, pH, dissolved minerals etc

LO3: To learn the ecological pyramids of fresh water from primary producers to higher tropic level organisms and lotic and lentic ecosystems and their salient features

LO4: To learn the knowledge of Morphometry of lotic and lentic ecosystems and collection of phytoplankton and zooplankton etc

THEORY

Unit - I

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India;

Unit - II

Nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms;

Unit - III

Classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity: Aquatic plants: characteristics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role.

Unit - IV

Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance;

Unit - V

Quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

PRACTICALS

Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies.

Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Enumeration and biomass estimation of benthos from lakes, ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Methodology for collection and identification bacteria in freshwaters bodies. Enumeration and biomass estimation of bacteria in freshwater bodies.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The students will be able to aware of the basic concept of Limnology and origin and evolution of fresh water on the earth

CO2: The students will be understood the physical properties of fresh water in different habitat and their quality such as dissolved gases, carbonate and bicarbonates, pH, dissolved minerals etc

CO3: The ecological pyramids of fresh water from primary producers to higher tropic level organisms and lotic and lentic ecosystems and their salient features will be learnt by the students

CO4: Students will be able to gather knowledge of morphometry of lotic and lentic ecosystems and collection of phytoplankton and zooplankton etc and practically, they will be fully aware of the fresh water ecosystems

Outcome Mapping

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

CO	3		3		2				2		
4											

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3				3		
CO2	3				3		
CO3	2				2		
CO4							
Total	8				8		

BFSC-207 MARINE BIOLOGY 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

- L01:** To understand the major division of marine environment and major biological groups and classification phytoplankton
- L02:** To become aware of the environmental variables that is affecting the primary production and energy flow through the food chain
- L03:** To understand the Inter tidal ecology: rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation and classification, physico-chemical factors, biota and productivity, examples of some Indian Estuaries and boring and fouling organisms
- L04:** To learn practical knowledge on collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, marine organisms and also inter tidal organisms

THEORY

Unit - I

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, sea weeds, major zooplankton groups.

Unit - II

Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries.

Unit - III

Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation.

Unit - IV

Mud banks: formation, characteristics, Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms.

Unit - V

Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species, Blooms, Red tides: cause and effects.

PRACTICALS

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, Collection preservation and analysis of inter tidal organisms

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

- CO1:** The students will be able to understand the major division of marine environment and major biological groups and classification phytoplankton
- CO2:** Students will also become aware of the environmental variables which are affecting the primary production and energy flow through the food chain
- CO3:** The understanding of the relationship between phytoplankton and zooplankton in aquatic ecosystem and inter tidal ecology and rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation and classification, physico-chemical factors, biota and productivity, examples of some estuaries and boring and fouling organisms will

be made to the students

CO4: Students will be learnt the practical knowledge on collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, marine organisms and also inter tidal organisms

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2			3		
CO2	3			3	3		
CO3	3			3	3		
CO4							
Total	9	2		6	9		

BFSC-208 FOOD CHEMISTRY AND FISH NUTRITION 3 (2+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To understand the fish Nutrition and structure and Composition and their properties and digestion and Metabolism

LO2: To become aware of different methods fish muscle carbohydrates. Lipids - metabolism of lipids, oxidation of fatty acids; lipoproteins, proteins in foods - role in hydration, native and denatured proteins

LO3: To understand the composition of fish with emphasis on nutritional value and minerals in fish - micro- and macro-elements, trace elements, significance in human nutrition etc

LO4: To learn the proximate composition of crude protein, fat, ash (including acid soluble) in fish. Determination of energy value of fish and estimation of glucose and salt content in foods etc

THEORY

Unit - I

Composition of food and nutritional value; Moisture in foods. Biological oxidation, electron transport chain, P/O ratio, oxidative phosphorylation. Carbohydrates - Naturally occurring polysaccharides in foods, Seaweed polysaccharides: Sources and their uses; Browning reactions enzymatic and non-enzymatic; Lipids - metabolism of lipids, oxidation of fatty acids; lipoproteins - VLDL & HDL and their importance.

Unit - II

Proteins - metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance, deamination reactions and nitrogen excretion with special reference to fish; Fish muscle proteins - chemical changes in muscle during contraction; Proteins in foods - role in hydration, native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins.

Unit - III

Nutritive value of foods - Energy value and energy requirements and their estimation; Water, electrolytic and acid-base balance; Nutritive value of proteins Concepts of Biological Value, Protein Efficiency Ratio, digestibility coefficient, NPU values, pepsin digestibility; Role of dietary fibre in human nutrition.

Unit - IV

Composition of fish with emphasis on nutritional value; Amino acids of fish and shellfishes - Importance of essential amino acids. Fish lipids: fatty acids, nutritional quality; Role of fish lipids in human nutrition; Non-protein nitrogen substances in fishes; Vitamins in fish - water soluble, fat soluble, significance in human nutrition; Minerals in fish - micro- and macro-elements, trace elements, significance in human nutrition. Other

functional bio-molecules in fish :peptides, collagen and squalene; Effect of different kinds of cooking fish - curry, frying, steaming, smoking, fermentation on nutrition value.

Unit - V

Chemistry of taste, flavour and odour components in foods - flavour intensifiers, synthetic flavouring substances. Taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavor potentiators, surface active agents, non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and physical method.

PRACTICALS

Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish. Determination of energy value of fish. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Use of pH meter. Estimation of dietary fibre in foods. Estimation of freshness quality indices such as TVB-N, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: Students will be understood the fish Nutrition and structure and Composition and their properties and digestion and Metabolism

CO2: Students will become aware of different methods of different methods fish muscle carbohydrates. Lipids - metabolism of lipids, oxidation of fatty acids; lipoproteins, proteins in foods - role in hydration, native and denatured proteins

CO3: Students will became aware of composition of fish with emphasis on nutritional value and minerals in fish - micro- and macro-elements, trace elements, significance in human nutrition etc

CO4: Students will be able to learn practical knowledge about the proximate composition of crude protein, fat, ash (including acid soluble) in fish. Determination of energy value of fish and estimation of glucose and salt content in foods etc

Outcome Mapping

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

CO 2	3			2						3	
CO 3	3			2				2		3	
CO 4	3									3	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1		2				3	
CO2						3	
CO3				2		3	
CO4						3	
Total		2		2		12	

BFSC-209 INFORMATION AND COMMUNICATION TECHNOLOGY 2 (1+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

- L01:** To learn the technology computer study all kinds of software and hardware systems and basic components of systems
- L02:** To familiarise with system software and application software and application programmes. Programming languages and to learn Programme execution modes
- L03:** To learn the techniques involved computer network and all software programmes, settings documents and related programmes
- L04:** To understand the data communication networks and Stand-alone and communication modes and also to learn Computer networks and local Area network, wide area network
- L05:** To learn the practical knowledge of MS Office and fisheries software and the Word Processor and application of word processors and usage of computer software

THEORY

Unit - I

IT and its importance. IT tools, IT-enabled services and their impact on society. Computer fundamentals. Hardware and software; input and output devices.

Unit - II

Word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts.

Unit - III

Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems.

Unit - IV

Local area network (LAN), Wide area network (WAN), Internet and World Wide Web, HTML and IP. Introduction to MS Office - Word, Excel, Power Point.

Unit - V

Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo's model, feedback and barriers to communication

PRACTICALS

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

- CO1:** The technology computer study all kinds of software and hardware systems and basic components of systems will be understood and perceived by the students
- CO2:** The students will be familiarised with system software and application software and application programmes also the students will be made to learnt the programming languages and to learn Programme execution modes etc
- CO3:** The techniques involved computer network and all software programmes, settings documents and related programmes will be fully learnt by the students
- CO4:** The students will be made understood the data communication networks and Stand-alone and communication modes and also to learn Computer networks and local Area

network, wide area network etc

C05: Students will be benefitted by learning the practical knowledge of MS Office and fisheries software and the Word Processor and application of word processors and usage of software

Outcome Mapping

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

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

BFSC-210* PHYSICAL EDUCATION, FIRST AID & YOGA PRACTICES 1 (0+1)

LEARNING OBJECTIVES (LO):

This course is being offered with the following objectives

LO1: To learn the physical education: definition, objectives, scope, history, development and importance; physical culture

LO2: To understand the Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports; Governance of sport in India; Important national sporting events

LO3: To learn the Need and requirement of first aid. First Aid equipments and upkeep. Handling and transport of injured I traumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration etc

PRACTICALS

Introduction to physical education: definition, objectives, scope, history, development and importance; physical culture; Meaning and importance of Physical Fitness and Wellness; Physical fitness components - speed, strength, endurance, power, flexibility, agility, coordination and balance; Warming up - General & Specific & its Physiological basis; Test and measurement in physical education; Training and Coaching - Meaning & Concept; Methods of Training; aerobic and anaerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports; Governance of sport in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipments, skill, technique, style and coaching of major games(Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics.

Need and requirement of first aid. First Aid equipments and upkeep. Handling and transport of injured I traumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration. Treatment of injuries (wounds and bleeding) - methods of dressing and bandages; first-aid procedure for injured bones. Handling unconsciousness; Treatment of burns and scalds. Emergency procedure for poisoning with special references to snake bite. Injuries I accidents in fishing, fish processing factories, chemical laboratories and their treatments. Shock injuries to muscles and joints and treatments. Sports injuries and their treatments.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1: The physical education: definition, objectives, scope, history, development and importance; physical culture will be understood and perceived by the students

CO2: The students will be the Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports; governance of sport in India; Important national sporting events

CO3: The techniques involved requirement of first aid. First Aid equipments and upkeep. Handling and transport of injured I traumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration etc will be known to

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1				3			
CO2							
CO3						3	
Total				3		3	

SEMESTER III

BFSC-301 ORNAMENTAL FISH PRODUCTION AND MANAGEMENT 2 (1+1)

LEARNING OBJECTIVE (LO):

LO1: To study endemic and exotic ornamental trade.

LO2: To learn about water quality management in the aquarium.

LO3: To understand aquarium plants and associated components filters and lighting.

LO4: To learn about breeding and rearing of ornamental brood stocks.

LO5: To understand the common diseases and packaging methods of ornamental fishes.

THEORY

Unit – I

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium.

Unit – II

Water quality management. Water filtration system- biological, mechanical and chemical. Types of filters.

Unit – III

Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds.

Unit – IV

Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains.

Unit – V

Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

PRACTICALS

Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chichlids, gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

TEXT BOOKS

1. Wolfgang Wickler, 1963. Breeding Aquarium Fishes. Studio Vista
2. Alan Mark Fletcher, 1968. Unusual Aquarium Fishes. J.B.Lippincott Company.
3. Stephen Spotte, 1973. Marine Aquarium Keeping the Science Animals and Art. A. Wiley – Inter Science Publication.
4. Adey, W.H. and K. Loveland, 2007. Dynamic aquarium building restoring living ecosystem, 508 pp.

REFERENCE BOOKS

1. Herbert R.Axelrod and Leonard P.Schultz, 1955. Hand book of tropical aquarium Fishes. McGraw – Hill Book Company, 11.
2. Dick Mills, 1987. The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited, 208 pp.
3. ErHunnam, 1989. The Living Aquariums. NORDBOK, 240 pp.
4. John Dawes, 1995. Live bearing Fishes (A guide to their Aquarium care, Biology and Classification) Cassell Pvt., London
5. Walter H. Adey and Karen Loveland, 1998. Dynamic Aquaria Building Living Ecosystems. Academic Press.
6. Sebastian J. Kuravamveli, 2002. The Aquarium Handbook. Amity Aquatech pvt. Ltd., Cochin – 28.
7. Sundararaj, V. and J.M. Sathish, 2005. Tropical marine aquarium. Yegam Publications, Chennai, 144 pp.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come.

CO1:	To understand the clear understanding on endemic and exotic ornamental.
CO2:	To understand the in depth knowledge on water quality management in the aquarium.
CO3:	To understand the clear in depth knowledge on aquarium plants and associated components filters and lighting.
CO4:	To understand the clear knowledge on breeding and rearing of ornamental brood stocks.

CO5:	To understand the clear understanding on the common diseases and packaging methods of ornamental fishes.
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Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3		
CO2				3	3		
CO3	3				3	3	3
CO4	3	3	3		3	3	3
CO5	3	3	3	3	3	3	
Total	12	9	9	9	15	09	06

LEARNING OBJECTIVE (LO):

LO1: To study shore based and sea-based aquaculture.

LO2: To learn about fin and shell fishes of fresh, brackish and marine waters.

LO3: To understand shore based commercial and traditional aquaculture.

LO4: To learn about different methods of culture like, rafts, racks, cages and poles.

LO5: To understand the growth, survival and productivity of different aquaculture systems.

THEORY

Unit – I

An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India.

Unit – II

Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, Seed resources.

Unit – III

Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish.

Unit – IV

Methods of Shellfish Culture rafts, racks, cages, poles and ropes., Water and soil quality management.

Unit – V

Estimation of growth, survival and pond productivity. Seaweed culture, Pearl culture, Sea ranching.

PRACTICALS

Identification of important cultivable species. Collection and identification of commercially important seed of fish and shellfishes. Types of fertilizers - Pond preparation. Seed selection, quality and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

TEXT BOOKS

1. CIFE, 1993. Training Manual on Culture of Live Food Organisms for AQUA Hatcheries. Central Institute of Fisheries Education, Versova, Mumbai.
2. MPEDA, 1993. Handbook on Aqua Farming - Live Feed. Micro Algal Culture. MPEDA Publication.
3. Santhanam, R., M. Ramnathan and Venkataramanujam, 1997. A Manual of Methods in Plankton. Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Tuticorin.
4. Hagiwara, A., T.W. Snell, E. Lubzens and C.S.Tamaru, 1997. Live Food in Aquaculture. Proceedings of the Live Food and Marine Larviculture Symposium. Kluwer.
5. Finn, R.N. and B.G.Kapoor, 2008. Fish Larval Physiology. Science Publ.

REFERENCE BOOKS

1. Tonapi, G.T., 1980. Freshwater Animals of India. Oxford & IBH.
2. Muthu, M.S., 1983. Culture of Live Feed Organisms. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.
3. Sorgeloos, P. and K.S.Pandian, 1984. Culture of Live Food Organisms with Special Reference to Artemia Culture. CMFRI Spl. Publ. No. 15.
4. Ojha, J.S., 2005. Aquaculture Nutrition and Biochemistry. Daya Publ.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge on shore based and sea based aquaculture.
CO2:	To understand the detailed knowledge on fin and shell fishes of fresh, brackish and marine waters.
CO3:	To understand the clear understanding on shore based commercial and traditional aquaculture.
CO4:	To understand the knowledge on different methods of culture like, rafts, racks, cages and poles.
CO5:	To understand the clear knowledge on growth, survival and productivity of different aquaculture systems.

OUTCOME MAPPING

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3		
CO2				3	3		
CO3	3				3	3	3

CO4	3	3	3		3	3	3
CO5	3	3	3	3	3	3	
Total	12	9	9	9	15	09	06

BFSC-303 FISH IMMUNOLOGY 2 (1+1)

LEARNING OBJECTIVE (LO):

LO1: To study the drug development from fin and shell fishes.

LO2: To learn about source and classification of drugs.

LO3: To understand pharmacotherapeutics and drug classification .

LO4: To learn about pharmacodynamics, dose response and efficacy.

LO5: To understand drug action and experimental pharmacology.

THEORY

Unit – I

Introduction to Pharmacology: History, importance, terms and definitions, drug development, screening and nomenclature, scope of pharmacology in fishes.

Unit – II

Route of administration and method of application to fish. Source of drugs. Pharmacotherapeutic classification of drugs.

Unit – III

Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and excretion of drugs. Factors influencing drug metabolism.

Unit – IV

Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non receptor mediated action. Dose Response Relationship, half life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs.

Unit – V

Salient features in drug acting on digestive system, nervous system and cardiovascular system. Drugs used in fish transportation. Recent advances in pharmacology, biostatistics in experimental pharmacology, pharmaceutical industry.

PRACTICALS

Introduction to Pharmacy, Metrology, Prescription writing, Preparation of drug solution, Source and chemical nature of drugs, Incompatibility, Pharmaceutical technology, Bioassay of drugs, Animal models in pharmacological experiments, Methods of application of drugs in fish.

TEXT BOOKS

1. Ellis, A.E., 1988. Fish Vaccination. Academic Press.
2. Iwama, G. and T. Nakanishi, 1996. The Fish Immune System. Organism, Pathogen and Environment. Academic Press.
3. Janis, K. ,1997. Immunology. 3rd Ed. WH Freeman.
4. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell, 2003. Harper's illustrated Biochemistry. Appleton & Lange.
5. Swain, P., P.K. Sahoo and S. Ayyappan, 2005. Fish and Shellfish Immunology: An Introduction. Narendra Publ. House.
6. Swain, P., 2006. Fish and shellfish immunology, 246 pp. Narender publishers.

REFERENCE BOOKS

1. Van Oss, C.J. and M.H.V. Van Regenmortel, 1994. Immunochemistry. CRC Press.
2. Iwama, G. and T. Nakanishi, 1996. The Fish Immune System. Organism, Pathogen and Environment. Academic Press.
3. Ivan M. Roitt, J. Brostoff and D. K. Male, Immunology, Gower Medical Publishing, London.1993.
4. Clark WR, The experimental foundations of modern immunology. John Wiley and Sons Inc.New York. 1991.
5. Janis Kuby, Immunology, II edition. W. H. Freeman and Company, New York. 1993.
6. Janeway Travers, Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd ed.,1997.
7. Peter J. Delves, Ivan M. Roitt, Encyclopedia of Immunology; Academic Press. 2nd Ed., 1998.
8. Chapel H and Halbey M, Essentials of Clinical Immunology. ELBS. 1986.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge on drug development from fin and shell fishes.
CO2:	To understand the detailed knowledge on source and classification of drugs.
CO3:	To understand the clear understanding on pharmacotherapeutics and drug classification.
CO4:	To understand the knowledge on pharmacodynamics, dose response and efficacy.
CO5:	To understand the clear knowledge on drug action and experimental pharmacology.

OUTCOMEMAPPING

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

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

Total	15	15	09	09	09	09	09
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BFSC-304 MARINE FISHERIES 3 (2+1)

LEARNING OBJECTIVE (LO):

LO1: To study the world marine fishery resources.

LO2: To learn about major fisheries of India.

LO3: To study demersal and deep-sea fisheries.

LO4: To learn about shell fish and seaweed resources of India.

LO5: To understand traditional and modern gears used in fisheries.

THEORY

Unit – I

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Potential marine fishery resources of the India's EEZ.

Unit – II

Major exploited marine fisheries of India, their developmental history and present status. Important pelagic resources of India.

Unit – III

Important demersal resources of India. - Deep sea fisheries resources.

Unit – IV

Important shellfish and seaweed resources of India.

Unit – V

Traditional, motorized and mechanized fisheries according to major gears. GIS and Remote sensing in marine capture fishery. Marine Fisheries Resource conservation.

PRACTICALS

Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data. Participation in fishing cruises. GIS and remote sensing in marine capture fishery.

TEXT BOOKS

1. Samuel, C.T., 1968. Marine Fisheries in India. Narendra Publ. House.
2. Kurian, C.V. and V.O. Sebastian, 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
3. Bal, D.V. and K.V. Rao, 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill.
4. Yadav, B.N., 1997. Fish and Fisheries. 2nd Ed. Daya Publ. House.
5. Peter, B.M. and J.C. Joseph Jr., 2000. Fishes- An Introduction to Ichthyology. 4th Ed. Prentice Hall.
6. Dholakia, A.D., 2004. Fisheries and Aquatic Resources of India. Daya Publ. House.

REFERENC BOOKS

1. Shanbhogue, S.L., 2000. Marine Fisheries of India. ICAR.
2. Chandra, P., 2007. Fishery Conservation, Management and Development. SBS Publ.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge on marine fishery resources.
CO2:	To understand the detailed knowledge on major fisheries of India.
CO3:	To understand the clear understanding on demersal and deep sea fisheries.
CO4:	To understand the knowledge on shell fish and seaweed resources of India.
CO5:	To understand the clear knowledge on traditional and modern gears used in fisheries.

OUTCOME MAPPING

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3				
CO3	3	3		3			3
CO4	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	15	15	09	09	09	09	09

BFSC-305 AQUATIC ECOLOGY AND BIODIVERSITY 3 (2+1)

LEARNING OBJECTIVE (LO):

- LO1:** To study the flora, fauna and animal associations in aquatic ecosystems.
- LO2:** To learn about importance of aquatic biodiversity and associated ecosystem.
- LO3:** To understand the conservation of habitats and management.
- LO4:** To learn about conservation of aquatic mammals and reptiles.
- LO5:** To understand the biology of aquatic vertebrates and invertebrates.

THEORY

Unit – I

Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship.

Unit – II

Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destruction, introduction of exotic species.

Unit – III

Conservation of habitats, marine parks and sanctuaries. Conservation programmes for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Unit – IV

Selected aquatic mammal, reptile, amphibian and birds species of India relevant to fisheries: taxonomic status, identification characters, distribution, abundance, habitat, exploitation, threats and conservation.

Unit – V

Biology of aquatic animals: Cetaceans (whales, dolphins, porpoises and narwal), Sirenia (manatees and dugongs), Carnivora (seals, sea lions walruses, polar bear and otter), Sea turtles, tortoise, crocodiles, sea/freshwater snakes and amphibians. IUCN criteria Red list, Wild Life (Protection) Act.

PRACTICALS

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to mangroves, marine parks,

sanctuaries, coralreefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices.

TEXT BOOKS

1. Sverdrup, H.V., M.W. Johnson and R.H. Fleming, 1959. The Oceans – Their Physics, Chemistry and General Biology. Prentice Hall.
2. Raymont, J.E.G., 1973. Plankton and Productivity in the Oceans. Pergamon Press.
3. McCormick, J.M. and J.V. Thiruvathaakal, 1976. Elements of Oceanography. WB Saunders.
4. Balakrishnan Nair, N. and D.M. Thampy, 1980. A Text Book of Marine Ecology. The MacMillan Co.

REFERENCE BOOKS

1. Odum, E.P., 1987. Basic Ecology. Saunders College Publication, Philadelphia
2. Gross G., 1993. Oceanography: A View of the Earth. 6th Ed. Prentice Hall.
3. Iversen, E.S., 1996. Living Marine Resources. Chapman & Hall.
4. Castro, P. and M.E. Huber, 1997. Marine Biology. 2nd Ed. McGraw Hill.
5. Nybakken, J.W., 1997. Marine Biology - An Ecological Approach. 4th Ed. Addison Wesley.
6. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction to the World's Oceans. 6th Ed. McGraw Hill.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge on flora, fauna and animal associations in aquatic ecosystems
CO2:	To understand the detailed knowledge on aquatic biodiversity and associated ecosystem
CO3:	To understand the clear understanding on conservation of habitats and management
CO4:	To understand the knowledge on conservation of aquatic mammals and reptiles
CO5:	To understand the clear knowledge on biology of aquatic vertebrates and invertebrates

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3				3	3		3
CO4		3		3	3	3	3
CO5	3	3	3	3	3	3	3
Total	09	12	09	09	15	12	09

BFSC-306 FREEZING TECHNOLOGY 2 (1+1)

LEARNING OBJECTIVE (LO):

LO1: To study the freezing technology of fin and shell fishes.

LO2: To learn about preservation, spoilage and storage of sea foods.

LO3: To understand the different types of freezing.

LO4: To learn about changes during storage.

LO5: To understand different types of thawing and HACCP in fish processing.

THEORY

Unit – I

Introduction to freezing technology; characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants.

Unit – II

Principles of low temperature preservations. Chilling of fish methods and equipment for chilling; icing quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals.

Unit – III

Freezing of fish fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish for freezing.

Unit – IV

Changes that occur during frozen storage microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments polyphosphate, glazing, antioxidants, packaging.

Unit – V

Thawing of frozen fish methods of thawing. Transportation of frozen fish, cold chain, quality control, HACCP in freezing industry.

PRACTICALS

Sanitation and plant housekeeping; chilling and freezing equipment, instruments; packages and product styles; methods of icing fish; cooling rate; preservation by chilled sea water; freezing and thawing curves; freezing of different varieties of fish and shellfish; estimation of drip; determination of quality changes during frozen storage; inspection of frozen fishery products; visits to ice plants, cold storages and freezing plants.

TEXT BOOKS

1. Fennema, K., W.D. Powrie and E.H. Marth, 1973. Low Temperature Preservation of Foods and Living Matter. Marcel Dekker.
2. Clucas, I.J., 1981. Fish Handling, Preservation and Processing in the Tropics. Parts I, II. FAO.
3. Andrew, C.C., 1990. Food Refrigeration Processes. Elsevier.
4. Hall, G.M. (Ed), 1992. Fish Processing Technology. Blackie.

5. Balachandran, K.K.,2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House.
6. Gopakumar, K. (Ed.), 2002. Text Book of Fish Processing Technology.ICAR.
7. Rautenstraub, B. and T. Liehr, 2002. Fish technology, 494 pp., Springer publishers.

REFERENCE BOOKS

1. Rudolf, K., 1969. Freezing and Irradiation of Fish. Fishing News (Books).
- 2.Regenssein, J.M. and C.E. Regenssein, 1991. Introduction to Fish Technology. Van Nostrand Reinhold.
3. Nambudiri ,D.D., 2006. Technology of Fishery Products. Fishing Chimes.
4. Sen, D.P., 2005. Advances in Fish Processing Technology. Allied Publ.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge onfreezing technology of fin and shell fishes.
CO2:	To understand the detailed knowledge on preservation, spoilage and storage of sea foods.
CO3:	To understand the clear understanding on different types of freezing.
CO4:	To understand the knowledge on changes during storage.
CO5:	To understand the clear knowledge on different types of thawing and HACCP in fish processing.

Outcome Mapping

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

CO 4	3	3	3	3	3				3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4				3	3	3	3
CO5	3	3	3	3	3	3	3
Total	12	12	09	09	15	15	09

BFSC-307 REFRIGERATION AND EQUIPMENT ENGINEERING 3 (2+1)

LEARNING OBJECTIVE (LO):

LO1: To study the law of thermodynamics and types of refrigeration

LO2: To learn about refrigeration technology

LO3: To understand the compressors and refrigerants

LO4: To learn about different types of freezers

LO5: To understand refrigeration effect and use in freezing process

THEORY

Unit – I

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work-A path function. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, Application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy. Refrigeration: History of refrigeration, Definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system.

Unit – II

Refrigeration plant: Layout of refrigeration plant, Construction. Insulating materials used for the cold storage construction, Frozen product storage capacity of cold storage, usage of Ante-room. Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle.

Unit – III

Compressors: Definition, Types of compressor, construction, working principle advantages and disadvantages. Evaporator: Definition, Types of Evaporator, construction, working principle advantages and disadvantages. Condenser: Definition, Types of Condenser, Cooling Towers, construction, working principle, advantages and disadvantages. Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection.

Unit – IV

Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Ice- plant: Ice plant planning Brine tank construction, preparation of brine, Types of ice, Storing of ice, Equipments used in ice plants. Freezers: Definition, Design and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated sea water (RSW), Chilled sea water (CSW). Refrigerated transport.

Unit – V

Cooling load: Unit of refrigeration, coefficient of performance (C.O.P), Refrigeration effect, study and use of Psychometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipments. Theory of machines: Transmission of power, friction wheels, shaft, gears, belt and Chain drive. Study of equipments used in fish processing with particular reference to canning, sausage, freeze drying and irradiation. Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

PRACTICALS

Drawing of Refrigeration and Fish processing machineries plant layout, Graphically re presented symbols used in refrigeration, Handling and operation of compressors, condensers, evaporators expansion valves, low and high pressure switches. Study of auxiliary equipments: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Power transmission line diagram of different fish processing machineries. Visit to processing plant refrigeration plant, Visit to ice plant, Visit to fishing harbor to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

TEXT BOOKS

1. Sternin, U.G., I.V. Nikonorou and B.K.Yu, 1976. Electrical Fishing. KeterPubl.House.
2. Hersom, A.C. and E.D.Hulland, 1980. Canned Foods. Chemical Publ. Co.
3. Hall, GM. (Ed)., 1992. Fish Processing Technology. Blackie.
4. Larousse, J. and B.E. Brown, 1997. Food Canning Technology. Wiley VCH.
5. Balachandran, K.K., 2002. Fish Canning Principles and Practices. CIFT, Cochin.
6. Ayyappan, V.P., 2002. Elements of Electrical Technology. CIFNET, Cochin.
7. Gopakumar, K., 2002. Text Book of Fish Processing Technology. ICAR.
8. Ninawe, A.S. and K. Rathnakumar, 2008. Fish processing technology and product development, 562 pp. Narender publishers.
9. Shawyer, M. and A.F.M. Pizzali, 2003. The Use of Ice on Small Fishing Vessels. FAO Tech. Paper No. 436. Rome.

REFERENCE BOOKS

1. Stumbo, 1973. Thermo Bacteriology in Food Processing. CRC, Academic Press.Nambudiri DD. 2006. Technology of Fishery Products. Fishing Chimes.
2. Zeathen, P., 1984. Thermal Processing and Quality of Foods. Elsevier.
3. Warne, D., 1988. Manual on Fish Canning. FAO Fisheries Tech. Paper 285.Thorne S. 1991. Food Irradiation. Elsevier.
4. Joshy, C.D. and M. Devadhason, 2001. Basic Electronics and Fish Finding Equipments. CIFNET, Cochin.
5. Venugopal, V., 2006. Seafood Processing. Taylor & Francis.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge on the law of thermodynamics and types of refrigeration.
CO2:	To understand the detailed knowledge on refrigeration technology.
CO3:	To understand the clear understanding on the compressors and refrigerants.
CO4:	To understand the knowledge on different types of freezers.
CO5:	To understand the clear knowledge on refrigeration effect and use in freezing process.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3

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

**BFSC-308 FISHERIES EXTENSION EDUCATION AND
PERSONALITY DEVELOPMENT 3 (2+1)**

LEARNING OBJECTIVE (LO):

- LO1:** To study the concept, objectives and principles of fisheries extension.
- LO2:** To learn about characteristics of technology and technology transfer process.
- LO3:** To understand the participatory planning, conflicts and gender in fisheries.
- LO4:** To learn about theories of learning and oral presentation skills.
- LO5:** To understand the public speaking and technical writing.

THEORY

Unit – I

Introduction to extension education and fisheries extension concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods individual, group and mass contact methods and their effectiveness, factors influencing their selection and use.

Unit – II

Characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations.

Unit – III

Extension program planning and evaluation steps and importance; participatory planning process. basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries.

Unit – IV

Theories of learning, learning experience, learning situation. Structural and functional grammar; meaning and process of communication; verbal and non-verbal

communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures.

Unit – V

Reading and comprehension of general and technical article, précis writing, summarizing, presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

PRACTICALS

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non governmental organizations through stakeholder analysis; case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

TEXT BOOKS

1. Morgan, C.T. and R.A .King, 1975. Introduction to Psychology. Tata McGraw Hill.
2. Chitambar, J.B., 1990. Introductory Rural Sociology. Wiley Eastern.
3. Haralambos, M., R.M. Heald and M. Holborn, 1995. Sociology: Themes and Perspectives. Collins Educ.
4. Sinha, V.R.P., 1999. Rural Aquaculture in India. FAO, United Nations, Thailand. RAP Publ.
5. Farming Freshwater Prawns. A Manual for the Culture of the Giant River Prawn (*Macrobrachium rosenbergii*). 2004. FAO Fisheries Tech. Paper No. 428, Rome.

REFERENCE BOOKS

1. Jerry, L.G., 1990. A Commodity Systems Assessment Methodology for Problem and Project Identification. Post Harvest Institute for Perishables. College of Agriculture, University of Idaho.
2. Scott, M., 2001. Distance Education and Distance Learning: A Framework for the Food and Agriculture Organization of the United Nations. Sustainable Development Department, FAO.
3. Loretta, S., 2005. Good Agricultural Practices Standards: A Way Towards Safe and Sustainable Agriculture? Seminar on Certification and Regulations for Food Safety, 31 May 2005, Wageningen.

COURSE OUTCOME (CO)

At the end of the course, the student will be familiarized with following out come

CO1:	To understand the clear knowledge on the concept, objectives and principles of
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	fisheries extension.
02:	To understand the detailed knowledge on characteristics of technology and technology transfer process.
03:	To understand the clear understanding on the participatory planning, conflicts and gender in fisheries.
04:	To understand the knowledge on theories of learning and oral presentation skills.
05:	To understand the clear knowledge on public speaking and technical writing.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3

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

BFSC-309 FISHERIES ECONOMICS 3 (2+1)

LEARNING OBJECTIVE (LO):

LO1: To study the micro and macro-economics.

LO2: To learn about micro-economics and production functions in capture and culture fisheries.

LO3: To understand the costs, returns and significance of marginal costs.

LO4: To learn about macro-economics, sustainable development and impact of globalization.

LO5: To understand the WTO, IPR and GMOs.

THEORY

Unit – I

Introduction to fisheries economics, basic economic terminologies micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country.

Unit – II

Micro-economics: theories of demand, supply; market equilibrium price, consumption, utility, Consumer surplus. Elasticity price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics production functions in capture and culture fisheries.

Unit – III

Costs and returns breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost.

Unit – IV

Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment;

balance of payments, economic growth and sustainable development. Globalization: dimensions and driving Forces.

Unit – V

Introduction to GATT and WTO. WTO Framework Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

PRACTICALS

Demand and supply functions of fish market determination of equilibrium price for fish and fisheries products, calculation of price, income and cross elasticities. Production function production with one or two variable inputs. Shifting demand and surplus curve and its importance in fish price. Economic analysis on cost, return and breakeven of any two production units like fish farm / shrimp farm / seed production unit /fish processing plant / export unit.

TEXT BOOKS

1. Clarke, C.W., 1976. Mathematical Bio-economics: The Optimal Management of Renewable Resources. John Wiley.
2. Munro, G.R. and A.Scott, 1984. The Economics of Fisheries Management. University of British Columbia.
3. Cunningham, S., M.R. Dunn and D.Whitmarsh, 1985. Fisheries Economics: An introduction St.Martin's Press
4. Dunne, E.B., 1990. Fisheries Economics - An Introduction. Mansell Publ.
5. Hartwick, J.M. and N.D. Olewiler, 1998. Economics of Natural Resource Use. 2nd Ed. Addison Wesley.
6. Grafton, Q.R., J. Kirkley, T, Kompas and D.Squire, 2006. Economics for Fisheries Management. Ashgate Publ. Co.

REFERENCE BOOKS

- 1.Shang, Y.C., 1981. Aquaculture Economics. Westview Press.

- 2.Mankar, V.G., 1984. Business Economics - Micro Analysis. Himalaya Publ.House.
- 3.Dwivedi, D.N., 2000. Managerial Economics. Vikash Publ. House.
- 4.Koutsoyiannis, A., 2000. Modern Microeconomics. The Mc Millan Press.
- 5.Samuelson, P.A. and W.D.Nordhaus, 2001. Economics. Tata McGrawHill
- 6.Palanisamy, K., P.Paramasivam, and C.R. Renganathan, 2002. Agricultural Production Economics, Analytical Methods and Applications Associated Publ. Co.
- 7.Ahuja, H.L., 2005. Macroeconomics- Theory and Practice. S. Chand & Co.
- 8.Dewett, K.K., 2005. Modern Economic Theory. S. Chand & Co.
- 9.Thomas, C.R. and S.C. Maurice, 2006. Managerial Economics. Tata McGraw-Hill.

Course Outcomes

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

CO1:	To understand the clear knowledge onthe micro and macroeconomics.
CO2:	To understand the detailed knowledge on micro-economics and production functions in capture and culture fisheries.
CO3:	To understand the clear understanding on costs, returns and significance of marginal costs.
CO4:	To understand the knowledge on macro-economics, sustainable development and impact of globalization.
CO5:	To understand the clear knowledge on WTO, IPR and GMOs.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	

CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3				3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	
CO2	3	3	3		3	3	
CO3	3	3		3	3	3	3
CO4	3	3		3	3	3	3
CO5			3	3	3	3	3
Total	12	12	09	09	15	15	09

Semester IV BFSC 401 COASTAL AQUACULTURE AND MARICULTURE

3(2+1)

LEARNING OBJECTIVE (LO):

LO1: To study the marine fish seed resources and breeding of fin fishes

LO2: To learn about breeding of cultivable fin fishes

LO3: To understand the different types of fin fish breeding

LO4: To learn about brood stock and spawn rearing and management

LO5: To study the breeding of major carps and other fin fishes

THEORY

Unit – I

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection

Unit – II

Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development.

Unit – III

Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection.

Unit – IV

Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport.

Unit – V

Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea horse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps.

PRACTICALS

Study of maturity stages in fishes. Collection and preservation of fish pituitary gland, preparation of PG extract, Hypophysation. Calculation of fecundity. Brood-stock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stages. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.

TEXT BOOKS

1. Lagler, K.P., J.E. Bardach, R.R. Miller and M.D.R. Passino, 1977. Ichthyology. John Wiley & Sons.

2. Midlen and Redding, T.A., 1998. Environmental Management for Aquaculture. Chapman & Hall.
3. Upadhyay, A.R., 2004. Aquatic Plants for the Wastewater Treatment. Daya Publ. House.
4. Nikolsky, G.V., 2008. The Ecology of Fishes. Academic Press.

REFERENCE BOOKS

1. Holmer, M., K. Black, C.M. Duarte, N. Marba and I. Karakassis (Eds.). 2008. Aquaculture in the Ecosystem. Daya Publ. House.

Course Outcomes

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

CO1:	To get Detailed knowledge on marine fish seed resources and breeding of fin fishes
CO2:	To understand the Detailed knowledge on breeding of cultivable fin fishes.
CO3:	To understand the Clear understanding on different types of finfish breeding
CO4:	To understand the Knowledge on brood stock and spawn rearing and management.
CO5:	To understand the Clear knowledge on breeding of major carps and other fin fishes

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3		3	3		3	3	3		3	3	
CO2	3		3			3	3	3		3	3	
CO3	3		3		3	3	3		3	3	3	3
CO4	3	3	3	3	3	3	3		3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

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

Semester IV

BFSC 402 GENETICS AND BREEDING

2(1+1)

LEARNING OBJECTIVES

LO1: To study the marine fish seed resources and breeding of fin fishes

LO2: To learn about breeding of cultivable fin fishes

LO3: To understand the different types of fin fish breeding

LO4: To learn about brood stock and spawn rearing and management

LO5: To study the breeding of major carps and other fin fishes

THEORY

Unit – I

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachium rosenbergii*, *P. vannamei*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, freshwater mussel, holothurians, horse-shoe-crab, *Sepia*, *Loligo*, crayfish etc.).

Unit – II

Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon* and *P. Vannamei*. Induced maturation in

Penaeus monodon and *P. vannamei* *P. indicus* by eye stalk ablation.

Unit – III

Reproductive physiology. Reproductive hormones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *Penaeus monodon* and *Macrobrachium rosenbergii*.

Unit – IV

Breeding and hatchery management of crabs, lobster, mussel, edible and pearl oyster.

Unit – V

Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

PRACTICALS

Identification of brood stock and maturity stages of important crustaceans and mollusks. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon*, *P. vannamei*. Identification of larval stages of important crustaceans and mollusks. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and transportation of shrimp/prawn seed and brood stock. Practice in the operation of Shrimp and Prawn hatcheries. Water treatment and management in Shrimp and Prawn hatcheries. Different Chemicals and drugs used in Shrimp / Prawn hatchery.

TEXT BOOKS

1. Das Pand Jhingran AG. 1976. Fish Genetics in India. Today & Tomorrow Publ.
2. Douglas T. 1998. Genetics for Fish Hatchery Managers. Kluwer.
3. Dunham RA. 2004. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI.
4. Malvee S. 2008. Fish Genetics. SBSPubl.
5. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.

REFERENCE BOOKS

1. Sinnot, E. W., L. Dunn and T. Dobzansky, 1989. Principles of Genetics. McGraw Hill.
2. Padhi, B. J. and R. K. Mandal, 2000. Applied Fish Genetics. Fishing Chime
3. Pandian, T. J., C. A. Strüssmann and M. P. Marian, 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ.

4. Reddy, P.V.G.K., 2005. Genetic Resources of Major Indian Carps. Daya Publ.

5. Reddy, P.V.G.K., S. Ayyappan, D.M. Thampy and Gopalakrishna, 2005. Text Book of Fish Genetics and Biotechnology. ICAR.

Course Outcomes

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

CO1:	To get Detailed knowledge on marine fish seed resources and breeding of fin fishes
CO2:	To understand the Detailed knowledge on breeding of cultivable fin fishes.
CO3:	To understand the Clear understanding on different types of finfish breeding
CO4:	To understand the Knowledge on broodstock and spawn rearing and management.
CO5:	To understand the Clear knowledge on breeding of major carps and other finfishes

Outcome Mapping

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

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

Semester IV

BFSC 403 FISH NUTRITION AND FEED TECHNOLOGY

3(2+1)

LO1: To study the candidate species of live feeds including the plankton

LO2: To learn about biology, culture and culture techniques of live food organism like algae and diatoms

LO3: To learn about biology, culture and culture techniques of live food organism rotifers and cladocerans

LO4: To learn about biology, culture and culture techniques of live food organism like tubifex, brine shrimp and chironomids

LO5: To study the culture of bait and forage fishes

THEORY

Unit – I

Candidate species of phytoplankton and zoo-plankton as live food organisms of fresh water and marine species. Tropic potentials- proximate composition of live feed.

Unit – II

Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green algae, Spirulina, diatoms.

Unit – III

Biology, culture requirements and methodology of important live food infusoria, rotifers, cladocerans.

Unit – IV

Biology, culture requirements and methodology of important live food tubifex, brineshrimp, chironomids.

Unit – V

Culture of earthworms, bait fish and forage fish.

PRACTICALS

Methods of collection and identification of different live food organisms.-Laboratory scale culture of selected live food organisms- (green algae, Spirulina, Chaetoceros, rotifer, Moina, copepod). Evaluation of live food organisms.-

Decapsulation and hatching method of brineshrimp cyst.

TEXT BOOKS

1. D' Abramo, L.R., D.E. Conklin and D.M. Akiyama, 1977. Crustacean Nutrition: Advances in Aquaculture. Vol. VI. World Aquaculture Society,
2. ADCP (Aquaculture Development and Co-ordination Programme). 1980. Fish Feed Technology. ADCP/REP/80/11. FAO.
3. De Silva, S.S. and T.A. Anderson, 1995. Fish Nutrition in Aquaculture, 319pp, Chapman & Hall Aquaculture Series.
4. Hertrampf, J.W. and F.P. Pascual, 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer.
5. Guillame, J., S. Kaushik, P. Bergot and R. Metallier, 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publ.
6. Halver, J. and R.W. Hardy, 2002. Fish Nutrition. Academic Press.
7. Elena, M., 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers.
8. Cyrino, E.P., D. Bureau and B.G. Kapoor, 2008. Feeding and Digestive Functions in Fishes. Science Publ.

REFERENCE BOOKS

1. New, M.B., 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. FAO-ADCP/REP/87/26.
2. NRC (National Research Council), 1993. Nutrient Requirements of Fish. National Academy Press, Washington.
3. Lavens, P. and P. Sorgeloos, 1996. Manual on the Production and Use of Live Food for Aquaculture. FAO Fisheries Tech. Paper 361, FAO.
4. Lovell, R.T., 1998. Nutrition and Feeding of Fishes. Chapman & Hall.
5. Hertrampf, J.W. and F.P. Pascual, 2000. Handbook on Ingredients for Aquaculture Feeds. Kluwer.
6. Houlihan, D., T. Boujard and M. Jobling, 2001. Food Intake in Fish. Blackwell.
7. Ojha, J.S., 2005. Aquaculture Nutrition and Biochemistry. Daya Publ
8. Houlihan, D., T. Boujard and M. Jobling, 2001. Food Intake in Fish. Blackwell

Course Outcomes

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

CO1:	To get Detailed knowledge on candidate species of live feeds including the plankton
CO2:	To understand Detailed knowledge on biology, culture and culture techniques of live food organism like algae and diatoms.
CO3:	Clear understanding on biology, culture and culture techniques of livefood organism rotifers and cladocerans
CO4:	To understand knowledge on biology,culture and culture techniques of live food organism like tubifex, brineshrimp and chironomids
CO5:	To understand the Clear knowledge on culture of baitandforagefishes

Outcome Mapping

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

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

LEARNING OBJECTIVE (LO):

LO1: To study the general toxicology, toxicokinetics and toxicodynamics

LO2: To learn about classification and testing of toxicants

LO3: To learn about systemic toxicology and response to toxicants like heavy metals

LO4: To learn about phytotoxicants

LO5: To study the toxicity of drugs in Aquaculture, drug and toxic residues

THEORY**Unit – I**

General Toxicology: Definitions; Branches of Toxicology; Historical developments; Factors modifying toxicity; Toxicokinetics; Toxicodynamics.

Unit – II

Classification of poison. Types of poisoning- Toxicity testing - Chronicity factor, Untoward effects, Common causes, Diagnosis of poisoning, General approaches to diagnosis and treatment of poisoning.

Unit – III

Systemic Toxicology: Toxicity caused by metal and non-metals.

Unit – IV

Phytotoxins- Toxic principles of various alkaloids and toxic plants. Drug toxicity and toxicity caused by Agrochemicals, mycotoxins and bacterial toxins.

Unit – V

Collections and dispatch of specimens in toxicological cases, toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish. Metabolism of toxic substances by aquatic organisms.

PRACTICALS

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe³⁺), Copper (Cu), Ammonia (ammonium ions) NH₄⁺ Chloride (Cl⁻), Phosphate (PO₄) Sulphate (SO₄) Fluoride (F⁻), Qualitative detection of Nitrite and Nitrate, Detection of hydrocyanic acid, Detection and Estimation of Mycotoxins, Test for detection of alkaloids, Estimation of LD₅₀ and ED₅₀. Demonstration of drug toxicity.

SUGGESTED READINGS:

1. Hoffman DJ. 1995. Handbook of Ecotoxicology. Lewis Publ.

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

LEARNING OBJECTIVES:

LO1: To study the Water as a biological medium. Gas exchange and muscle physiology

LO2: To learn about Circulation, Excretion, Osmoregulation and Sense organs

LO3: To learn about energy and metabolisms

LO4: To learn about reproductive physiology of fin and shell fishes

LO5: To study the effect of environmental factors on reproductive physiology of fin and shell fishes

THEORY

Unit – I

Water as a biological medium. Gas exchange; Muscle physiology.

Unit – II

Circulation; Excretion; Osmoregulation; Sense organs

Unit – III

Standard and active metabolism; Energy utilization; Energy and nutrient status of food; Nitrogen balance;

Unit – IV

Reproductive physiology, Structure and functions of important endocrine glands.

Unit – V

Effect of environmental factors on physiology of fin and shellfishes. Stress related physiological changes.

PRACTICALS

Estimation of oxygen consumption, Osmoregulation, ammonia excretion and carbon-dioxide output. Influence of temperature and salinity on metabolism. Hematology of fin and shellfishes. Histological techniques.

TEXT BOOKS

1. Adiyodi, K.G. and R.G.Adiyodi, 1971. Endocrine Control of Reproduction in Decapod Crustacea. Biology Reviews.

2. Hoar, W.S., D.J. Randall and E.M. Donaldson, 1983. Fish Physiology. Vol. IX. Academic Press

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

LEARNING OBJECTIVE (LO):

LO1: To study the basics of oceanography and relative terminologies

LO2: To study the physical oceanography

LO3: To learn about the physical properties of sea water

LO4: To learn about physical and chemical interactions in the oceans

LO5: To study the inorganic, organic and nutrient properties of sea water

THEORY**Unit – I**

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves.

Unit – II

Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino.

Unit – III

Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity.

Unit – IV

General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water

Unit – V

Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO₂ system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.

PRACTICALS

Operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, current meters, tidal gauges, echo-sounder. Determination of DO, CO₂ Alkalinity, Nitrates, phosphates and silicates in sea water.

TEXT BOOKS

1. Laevastu, T. and M.L. Hayes, 1981. Fisheries Oceanography and Ecology. Fishing News Books.
2. Grasshoff ,K, M. Ehrhardt and V.Kremling, 1983. Methods of Seawater Analysis. VerlagChemie.
3. Kennish ,MJ., 1989. Practical Handbook of Marine Science. CRC Press.

REFERENCE BOOKS

1. Lalli , C.M. and T.R. Parsons, 1993. Biological Oceanography: An Introduction. Elsevier.
2. Miller, C.B., 2004. Biological Oceanography. Blackwell.
3. Reddy, M.P.M. ,2007. Ocean Environment and Fisheries. Science Publishers.
4. Simpson, J.H. and J.Sharples, 2012. Introduction to the physical and biological oceanography and shelf seas, 424 pp., Cambridge University press.

Course Outcomes

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

CO1:	To get Detailed knowledge on oceanography and relative terminologies
CO2:	To understand the detailed knowledge about physical oceanography
CO3:	For Clear understanding on the physical properties of seawater
CO4:	To get Knowledge on physical and chemical interactions in the oceans
CO5:	To get Clear knowledge on inorganic, organic and nutrient properties of sea water

Outcome Mapping

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

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

LEARNING OBJECTIVE (LO):

LO1: To study the aquatic pollution and water quality parameters

LO2: To study the organic and inorganic pollutants

LO3: To learn about the microbial and sewage pollutions in the coastal ecosystems

LO4: To learn about estuarine ecosystems and GIS

LO5: To study the coastal zone regulation and its management

THEORY

Unit – I

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment, Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: **importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter. Excessive plant nutrients; Eutrophication; Red tides and fish kills.**

Unit – II

Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies.

Unit – III

Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Bio-corrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution. Solid waste management.

Unit – IV

Estuaries, Wet lands and Lagoons, Living resources Non-living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification.

Unit – V

Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection. Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry. Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries. Evaluation and Methodology; Social Impact Assessment and other developmental activities

PRACTICALS

Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Study of pathogenic and coliform bacteria. Bacteriological quality of water; Coliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters. Pollution flora and fauna: indicator species- algae, protozoa and insect larva. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study. Field visit to different coastal environments to study erosion of beaches, Identification of ecologically sensitive areas and protection, Study of CRZ, ICZM along the coastal belt, Study on implementation and violation of CRZ, Study of application of remote sensing and GIS, Project preparation of EIA.

TEXT BOOKS

1. Brahtz, J.F.P., 1972. Coastal Zone Management. UN Department of International Economic & Social Affairs, New York.
2. Cairns, J. Jr., 1994. Implementing Integrated Environmental Management Virginia Tech. University Trivedy RK. 1998. Advances in Wastewater Treatment Technologies Global Science.
3. Eckenfelder, W.W., 2000. Industrial Water Pollution Control. McGraw Hill.

4. Cheremisinoff , N.P., 2002. Handbook of Water and Waste Water Treatment Technologies. Butterworth – Heinemann.

5. Gray, N.F., 2004. Biology of Wastewater Treatment. Oxford University Press.

REFERENCE BOOKS

1. Coastal Area Management and Development 1982. UN Department of International Economic & Social Affairs, New York.

2. Clark, J.R., 1992. Integrated Management of Coastal Zones. FAO Fisheries Tech. Paper No. 327, Rome.

3. Khanna, B.K., 2000. All You Wanted to Know About Disasters. New India Publ. Agency.

4. David, S. and P.Jeremy, 2001. Inshore Fisheries Management. Methods and Technologies in Fish Biology and Fisheries. Vol. II Kluwer.

Course Outcomes

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

CO1:	To get Detailed knowledge on aquatic pollution and water quality parameters
CO2:	To understand Detailed knowledge about organic and inorganic pollutants
CO3:	For Clear understanding on the microbial and sewage pollutions in the coastal ecosystems
CO4:	To get Knowledge on estuarine ecosystems and GIS
CO5:	To get Clear knowledge on inorganic, organic and nutrient properties of sea water

Outcome Mapping

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

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

LEARNING OBJECTIVE (LO):

LO1: To study the canning and the various packaging materials

LO2: To study the thermal, pasteurization and sterilization methods

LO3: To learn about complete canning of fish and fishery products

LO4: To learn about process calculations and sterilization methods

LO5: To study the various spoilage and the standards

THEORY**Unit – I**

Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials and sub materials, their characteristics and suitability for canning. Classification of foods based on pH. Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches.

Unit – II

Principles of thermal processing. Heat resistance of microorganisms, heat penetration studies, mechanism of heat transfer. Cold spot and its importance, convection and conduction type of packs. Commercial sterility, Absolute sterility, pasteurization and sterilization.

Unit – III

Canning process, process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Canning of commercially important fin fishes, shell fishes and cephalopods.

Unit – IV

Process calculation by general/ graphical methods, estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D concept.

Unit – V

Spoilage of canned foods - types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal.

PRACTICALS

Types of cans, canning equipment and layout of cannery. Canning of different varieties of fish and shell fish. Cut out test of canned products. Examination of can double seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method. Study of spoilage condition in canned products. Familiarization with various packaging materials and container for fish products.

TEXT BOOKS

1. Hersom, A.C. and E.D. Hulland, 1980. Canned Foods. Chemical Publ. Co.
2. Hall, G.M. (Ed.), 1992. Fish Processing Technology. Blackie Balachandran KK. 2002. Fish Canning Principles and Practices. CIFT, Cochin.
3. Larousse, J. and B.E. Brown, 1997. Food Canning Technology. Wiley VCH.
4. Gopakumar, K., 2002. Text Book of Fish Processing Technology. ICAR.

REFERENCE BOOKS

1. Stumbo, 1973. Thermo Bacteriology in Food Processing. CRC, Academic Press.
2. Zeathen, P., 1984. Thermal Processing and Quality of Foods. Elsevier.
3. Warne, D., 1988. Manual on Fish Canning. FAO Fisheries Tech. Paper 285.
4. Thorne, S., 1991. Food Irradiation. Elsevier.
5. Gopakumar, K., 1993. Fish Packaging Technology - Materials and Methods. Concept Publ.
6. Balachandran, K.K., 2001. Post-Harvest Technology of Fish and Fish Products. Daya Publ.
7. Venugopal, V., 2006. Seafood Processing. Taylor & Francis.
8. Nambudiri, D.D., 2006. Technology of Fishery Products. Fishing Chimes.

Course Outcomes

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

CO1:	To get Detailed knowledge on canning and the various packaging materials
CO2:	To Detailed knowledge about thermal, pasteurization and sterilization methods
CO3:	For Clear understanding on complete canning of fish and fishery products
CO4:	To gain Knowledge on process calculations and sterilization methods
CO5:	To get Clear knowledge on various spoilage and the standards

Outcome Mapping

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

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

LEARNING OBJECTIVE (LO):

LO1: To study the fishing gears and its types

LO2: To study the various kinds of materials used in fish gear materials

LO3: To learn about mesh numbering and calculations

LO4: To learn about properties of netting materials

LO5: To study the classification gears and its parts

THEORY**Unit – I**

Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG). Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns.

Unit – II

Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test. Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines.

Unit – III

Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system: British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing;, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond; square hexagonal and their measurement.

Unit – IV

Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velocity, weather resistance, melting point and visibility. Chemical and Biological properties. Floats buoys its materials, types their

properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers types, materials, properties- negative buoyancy.

Unit – V

Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation. Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seam trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board.

PRACTICALS

Study of net making tools; Knots and hitches used in net making. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing: baiting, creasing and reducing mesh size step by step. Tailoring method : T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination. Joining of net pieces. Net mounting hanging coefficient, hung depth and their calculation. Selvedging. Methods of net mounting: reeving, stapling and norselling. Mending and net shooter techniques.

TEXT BOOKS

1. Baranov, F.I. ,1976. Selected Works on Fishing Gear. Vol. I. Commercial Fishing Techniques. Israel Programme for Scientific Translations,Jerusalem.
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3. Brandt, A.V., 1984. Fish Catching Methods of the World. Fishing News Books. Enterprises. Israel.Vol.2&3.
4. Ben-Yami, M., 1994. Purse Seining Manual. FAO Fishing Manual.
5. Biswas, K.P., 1996. Harvesting Aquatic Resources. Daya Publ. House.
6. Bjordal, A. and S. Lokkeborg, 1998. Long Lining. Fishing News Books.
7. Hameed, S.M. and M.R. Boopendranath, 2000. Modern Fishing GearTechnology. Daya Publ. House.

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1. Kristionsson, H., 1975. Modern Fishing Gear of the World. The White FriarsPress.
2. Fridman, A.L., 1986. Calculations for Fishing Gear Designs. FAO FishingManual. Fishing News Books.
3. FAO, 1987. Small Scale Fishing Gear.
4. Garner, J., 1988. Modern Deep Sea Trawling Gear. Fishing News Books.

5. Sreekrishna ,Y. and L. Shenoy, 2001. Fishing Gear and Craft Technology.ICAR.

Course Outcomes

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

CO1:	To get Detailed knowledge on fishing gears and its types
CO2:	To get Detailed knowledge about various kinds of materials used in fish gear materials
CO3:	For Clear understanding on mesh numbering and calculations
CO4:	To gain Knowledge on properties of netting materials
CO5:	To get Clear knowledge on classification gears and its parts

Outcome Mapping

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

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

V SEMESTER

BFSC-501 Finfish Hatchery Management 3 (2+1)

Learning Objective (LO):

01:	To understand the Fundamentals of fish nutrition and growth in fish
02:	To understand the various Methods of feed formulation and manufacturing and Forms of feeds
03:	To understand basic knowledge about use of preservatives and antioxidants to feed..
04:	To understand various methods of Feed evaluation and devices
05:	To understand the Factors affecting digestibility and Nutritional deficiency diseases.

THEORY

Unit – I

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning.

Unit – II

Methods of feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets.

Unit – III

Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants.

Unit – IV

Feed evaluation: feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods.

Unit – V

Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility Factors affecting digestibility-Nutritional deficiency diseases

PRACTICALS

Proximate composition analysis of feed ingredients and feeds. - Preparation of artificial feeds using locally available feed ingredients. - Determination of sinking rate and stability of feeds. -Effect of storage on feed quality.

Course Outcomes

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

01:	To Gain knowledge about nutritional requirements of cultivable fish and shellfish
02:	To understand Forms and types of feeds
03:	To understand process of preservation of feed
04:	To operate Feeding devices and methods of feeding
05:	To understand Non-conventional feed ingredients and anti-nutritional factors

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3	3		3		3
CO3	3	3	3	3	3		3
CO4	3			3			3
CO5		3		3		3	
Total	15	12	9	9	6	6	12

BFSC-502 Introduction to Biotechnology and Bioinformatics 3 (2+1)

Learning Objective (LO):

01:	To understand the Fundamentals of Immunology.
02:	To understand the various types of Antigens.
03:	To understand basic knowledge about the Defence mechanism in finfish and shellfish-specific and non-specific immune system.
04:	To understand about types of Vaccines and Immuno-stimulants.
05:	To understand the various immunoassays.

THEORY

Unit – I

Introduction -brief history of immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system.

Unit – II

Antigens structure and types. epitopes, haptens. Antibody fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. Antigen-antibody interactions-principle, antigen recognition by B-cells and T cells. Antigen-antibody reaction - Precipitin reactions, agglutination reactions. MHC complex types, structure, and functions.

Unit – III

Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish- specific and non-specific immune system. Pathogenicity and virulence. Sources of infection, transmission of disease producing organisms, portals of infection. Immunity to bacteria, fungi and parasites.

Unit – IV

Role of stress and host defense mechanism in disease development. Vaccines - types of vaccines whole cell vaccine, purified macromolecules, recombinant vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Immunostimulants types, mechanism of action, modes of administration.

Unit – V

Serological methods in disease diagnosis. Immunoassays – immune diffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

PRACTICALS

Collection, separation and identification of fish leucocytes. Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types of leukocytes and isolation of macrophages. Precipitin reactions - Agglutination test, immuno-gel diffusion, double immune diffusion, radial immune diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

Course Outcomes

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

PO1:	To Gain knowledge about cells and organs of the immune system.
PO2:	To understand Antigen-antibody interactions.
PO3:	To understand Sources of infection and transmission of diseases.
PO4:	To understand the mechanism of action and modes of administration of vaccines.
PO5:	To gain confidence in handling various serological methods in disease diagnosis.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3		3		3
CO3	3	3	3	3	3		3
CO4	3	3		3			3
CO5		3		3		3	3
Total	12	15	9	12	9	6	15

BFSC-503 Pharmacology 3 (2+1)

Learning Objective (LO):

LO1:	To understand the General characteristics of Zoonotic diseases.
LO2:	To understand Disease surveillance and reporting.
LO3:	To understand basic knowledge about Health management strategies in Aquaculture.
LO4:	To understand various Disease control through environmental management.
LO5:	To understand Principles of disease diagnosis.

THEORY

Unit – I

General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Zoonotic diseases.

Unit – II

Disease surveillance and reporting. Quarantine and health certification in aquaculture.

Unit – III

Health management strategies in Aquaculture: Vaccines, Immuno-stimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices. SPF and SPR stocks development and application. Bio-security principles, Sanitary and phytosanitary Agreement

Unit – IV

Disease control through environmental management. Importance of Biofilm, Biofloc, Periphyton in aquatic health management.

Unit – V

Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, rapid diagnostic methods.

PRACTICALS

General procedure for disease diagnosis. Methods of sampling fish and shellfish for disease diagnosis. Taxonomy, lifecycle and identification of fish and shellfish parasites .Sampling, preparation of media and culture of pathogenic bacteria: Techniques for bacterial classification. Techniques in disease diagnosis: Microbiological, haematological, histopathological, immunological, molecular techniques and biochemical tests. Agglutination test; challenge tests; purification of virus; stress related study of fish and shellfish; disease treatment.

Course Outcomes

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

D1:	To Gain knowledge about prevention and treatment of viral diseases and OIE listed diseases.
D2:	To understand Quarantine and health certification in aquaculture.
D3:	To understand Good and Best management practices
D4:	To understand the Importance of Biofilm, Biofloc, Periphyton in aquatic health management.
D5:	To understand molecular and antibody based diagnostic methods .

Outcome Mapping

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

CO5	3	3		3			3		3		3	3
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	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2			3		3		3
CO3	3	3	3		3	3	
CO4	3	3		3			3
CO5		3		3		3	3
Total	9	12	9	6	6	9	12

BFSC-504 Fish Toxicology 2 (1+1)

Learning Objective (LO):

01:	To understand the Scope and current scenario of therapeutics in aquaculture
02:	To understand the general principles and classification of Antibiotics
03:	To understand basic knowledge about Principles in preparation/formulation of Immuno-stimulants and Vaccines
04:	To understand various Therapeutants in aquaculture
05:	To understand the Drug formulation for aquaculture

THEORY

Unit – I

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA.

Unit – II

Antibacterial agents, mode of action, general principles, classification. Antibiotics, different classes and their mode of action, properties etc. Antibiotics used in aquaculture. Antibiotic resistance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoans.

Unit – III

Biologics: Immuno-stimulants and Vaccines- Principles in preparation/formulation, mechanism of action.

Unit – IV

Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anesthetics, flesh color enhancers, Chemicals of therapeutic value, Low regulatory priority aquaculture drugs.

Unit – V

Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders and dosage. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices, list of the drugs used in aquaculture with therapeutics.

PRACTICALS

Regulations of drug use. Introduction to antimicrobials, preparation of potassium permanganate solution, preparation of weak Tincture Iodine. Minimum inhibitory concentration (MIC). Five plate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.

Course Outcomes

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

PO1:	To Gain knowledge about Chemotherapy
PO2:	To understand about Antiparasiticides: Ectoparasites, Endoparasites and Protozoans
PO3:	To understand process of mechanism of action of Immuno-stimulants and Vaccines
PO4:	To have a wide knowledge about Classification of Therapeutants
PO5:	To understand mechanism of action of drug

Outcome Mapping

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

CO4						3	3		3			3
CO5	3	3		3			3		3		3	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3		3		3		3
CO3	3	3	3		3		
CO4	3	3		3			3
CO5		3		3		3	
Total	12	12	9	6	6	6	9

BFSC-505 Fish Population Dynamics and Stock Assessment 3 (2+1)

Learning Objective (LO):

LO1:	To understand the concept of population and unit stock
LO2:	To understand the Theory of life tables
LO3:	To understand basic knowledge about Estimation of total, fishing and natural mortality
LO4:	To understand Analytical models of fish stock
LO5:	To understand Open access fisheries.

THEORY

Unit – I

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment.

Unit – II

Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models.

Unit – III

Estimation of total, fishing and natural mortality. Trawl selection and gillnet selection. CPUE.

Unit – IV

Yield models. Analytical models of fish stock. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Eumetric fishing. The concept of Maximum Sustainable Yield and Maximum Economic Yield.

Unit – V

Monte Carlo simulation model and ECO PATH model. - Open access fisheries. Biological symptoms of under fishing and over fishing. Growth over fishing and recruitment over fishing. Fisheries regulations.

PRACTICALS

Study of length weight relationship- Segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Paulys integrated methods, graphical models. Estimation of Z, F and M. Estimation of net selectivity co-efficient. Fitting of surplus production model: Schaeffer model-Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN and FiSAT.

Course Outcomes

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

PO1:	To Gain knowledge about stock assessment. Segregation of stocks and Principles of stock assessment
PO2:	To understand growth parameters and graphical models
PO3:	To understand various estimation procedures for calculating total fishing and natural mortality
PO4:	To understand the concept of Maximum Sustainable Yield and Maximum Economic Yield
PO5:	To understand Biological symptoms of under fishing and over fishing

Outcome Mapping

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

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

BFSC-506 Fish By-Products and Waste Utilization 2 (1+1)

Learning Objective (LO):

01:	To understand the extraction purification preservation of oil from fish.
02:	To understand the preparation of Fish protein concentrate.
03:	To understand basic knowledge about seaweeds agar agar, algin, carrageenan.
04:	To gain knowledge about the uses of different parts of fish
05:	To understand the uses of Shrimp wastes chitin chitosan-production.

THEORY

Unit – I

Fish meal. Dry reduction and wet reduction methods specification packaging and storage.
Fish oil body oil liver oil extraction purification preservation storage application.

Unit – II

Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat,
functional fish protein concentrate and their incorporation to various products.

Unit – III

Fish silage acid silage fermented silage application. Utilization of seaweeds: agar agar, algin, carrageenan.

Unit – IV

Fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer.

Unit – V

Shrimp wastes chitin chitosan-production uses. Biochemical and pharmaceutical products

PRACTICALS

Preparation of fishmeal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, factice, pearl essence, chitin, chitosan and fish manure Preparation of acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

Course Outcomes

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

PO1:	To Gain knowledge about various storage and preservation methods oil from fish
PO2:	To understand the applications of Fish protein concentrate.
PO3:	To understand the various Utilization of seaweeds.
PO4:	To understand the economical use of fish
PO5:	To obtain Biochemical and pharmaceutical products from shrimp waste

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3		3		3		3
CO3	3		3		3		3
CO4	3	3		3			3
CO5		3		3		3	3
Total	12	12	9	6	6	6	15

BFSC-507 Microbiology of Fish and Fishery Products 3 (2+1)

Learning Objective (LO):

01:	To understand the Fundamentals about role of microorganisms in foods
02:	To understand the various Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food
03:	To understand various methods of fish preservation and processing
04:	To understand about various pathogens involved in food poisoning
05:	To have a wide knowledge about marine toxins and shellfish toxins

THEORY

Unit – I

Introduction and history of microorganisms in foods; Role and significance of microorganisms in nature and in foods; Sources and types of microorganisms in fish and fishery products.

Unit – II

Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food; Enumeration of microorganisms in food by conventional and rapid techniques.

Unit – III

Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals; Microbiology and spoilage of fresh, semi processed and processed fish and fishery products; Indicators of microbiological quality of fish and fishery products.

Unit – IV

Food borne pathogens involved in infective and intoxication type of food poisoning Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus their occurrence, growth, survival, pathogenicity and prevention.

Unit – V

Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

PRACTICALS

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae*, *Vibrio parahaemolyticus*, *E coli*, *Salmonella*, *Listeria monocytogenes* and faecal *Streptococci*. Biochemical tests for characterization of bacteria. Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

Course Outcomes

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

PO1:	To understand the Sources and types of microorganisms in fish and fishery products
PO2:	To understand the methods of Enumeration of microorganisms in food by conventional and rapid techniques
PO3:	To understand the Microbiology and spoilage of fresh, semi processed and processed fish and fishery products
PO4:	To clearly understand the occurrence, growth, survival, pathogenicity and prevention of pathogens
PO5:	To understand the biological hazards associated with fish and fishery products

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3		3		3		3
CO3	3	3	3	3	3	3	3
CO4	3	3		3			3
CO5		3		3		3	3
Total	12	12	9	9	6	6	15

BFSC-508 Aquaculture Engineering 3 (2+1)

Learning Objective (LO):

LO1:	To understand the Fundamentals of fish farm and types of fish farm
LO2:	To understand the various Methods of levelling a pond and calculation of volume of pond
LO3:	To understand basic knowledge about soil and its properties
LO4:	To understand various methods of Water distribution system and types of canals
LO5:	To understand the Layout plan and design of hatcheries

THEORY

Unit – I

Fish Farm- Definition, objectives, types of farms; fresh water, brackish water and marine farms. Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics. Land Surveying- definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey. Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass.

Unit – II

Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling. Plane table surveying- instruments required, working operation, methods. Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour. Calculation of area of regular and irregular plane surfaces, Trapezoidal and Simpsons rule, volume of regular and irregular shape as applied to stacks and heaps, calculation of volume of pond. Earth work calculations- excavation, embankment, longitudinal slope and cross slope, calculation of volume of earth work as applied to roads and channels.

Unit – III

Soil and its properties- classification of soil; soil sampling methods; three phase system of soil, definitions of soil properties and permeability of soil. Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish ponds, layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds; Types of ponds; nursing ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond etc., construction ponds viz., marking, excavation etc., Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes.

Unit – IV

Water distribution system- canal, types of canals; feeder canal, diversion canal etc., Pipe line system, Water control structures- types of inlet and out let and their construction. Water budget equation, Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc.,

Unit – V

Hatcheries - site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc, Raceway culture system- site selection, layout plan, types of raceway culture system viz., parallel system, series system etc., Aerators- principles, classification of aerators and placement aerators. Pumps- purpose of pumping, types, selection of pump, total head, horse power calculation. Filters- types and constructions.

PRACTICALS

Evaluation of potential site for aquaculture. Land survey chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations and water requirement calculation. Visit to different types of farms.

Course Outcomes

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

D1:	To Gain complete knowledge about farm construction
D2:	To understand various Earth work calculation processes
D3:	To understand process of Design of ponds, pond geometry; shape, size, bottom slope of pond, and construction of dykes
D4:	To have confidence in Site selection, planning and construction of coastal aqua farms
D5:	To understand about the various hatchery accessories like pumps, aerators and filters

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3	3	3	3		3
CO3	3	3	3	3	3	3	3
CO4	3	3		3		3	3
CO5		3		3		3	3
Total	12	12	9	12	6	12	15

BFSC-509 Fishing Craft Technology 2 (1+1)

Learning Objective (LO):

01:	To understand the History and development of fishing crafts
02:	To understand the various Methods of Calculating longitudinal and transverse sectional area of fishing craft
03:	To understand basic knowledge about choice of Boat building materials
04:	To understand the value of Maintenance of fishing vessels
05:	To understand the Constructional details of Steel, FRP, Ferro Cement and Aluminum boats

THEORY

Unit – I

Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel.

Unit – II

Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpsons rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT).

Unit – III

Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages.

Unit – IV

Deck fitting. Maintenance of fishing vessels. fouling and boring organisms; seasoning and preservation of wood.

Unit – V

Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.

PRACTICALS

Studies on traditional fishing crafts; Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing; Drawing of back bone assembly; U & V bottom hull of wooden boat; General view of boat; Drawing of sheer plan, body plan and half breadth plan; Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

Course Outcomes

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

PO1:	To Gain knowledge about Basic geometric concepts and important terminologies of fishing vessel.
PO2:	To understand various rules in construction of fishing gears
PO3:	To understand the advantages and disadvantages of boat building material
PO4:	To understand fouling and boring organisms and to prevent them.
PO5:	To understand the Introduction of Outboard and inboard engines.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3	3	3	3		3

CO3	3	3	3		3	3	3
CO4	3			3		3	
CO5		3		3		3	3
Total	12	12	9	9	6	12	12

VI SEMESTER

BFSC-601 Shellfish Hatchery Management 2 (1+1)

Learning Objective (LO):

01:	To understand the Fundamentals of Host, Pathogen and Environment interaction
02:	To understand the various Stress in aquaculture and its role in disease development
03:	To understand the Significance of Fin fish and Shellfish diseases in aquaculture
04:	To understand the various Nutritional diseases
05:	To understand the Case history and clinical sign in disease diagnosis.

THEORY

Unit – I

Host, Pathogen and Environment interaction. Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals, metabolites, free radicals, oxidants), soil and water parameters in fish health.

Unit – II

Stress in aquaculture and its role in disease development. Pathological processes: Cellular response to injury, inflammatory response to diseases.

Unit – III

Significance of Fin fish and Shellfish diseases in aquaculture. Pathogen city mechanism of parasite, bacteria, virus and fungus. Disease development process.

Unit – IV

Nutritional diseases. Non-infectious diseases.

Unit – V

Case history and clinical sign in disease diagnosis.

PRACTICALS

Live and post mortem examination of fish and shellfish. Pathology of organ systems. Histopathology of normal and diseased fish and shellfish, Diagnosis of abiotic fish diseases.

Course Outcomes

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

PO1:	To understand about Role of physical, chemical, soil and water parameters in fish health.
PO2:	To understand the various Pathological processes
PO3:	To understand the mechanism of parasite, bacteria, virus and fungus disease development process.
PO4:	To have a complete knowledge about non-infectious diseases
PO5:	To identify the clinical symptoms in disease diagnosis

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3		3	3		3
CO3	3	3	3		3	3	3
CO4	3			3			3
CO5		3		3		3	3
Total	12	12	6	9	6	9	15

BFSC-602 Microbial and Parasitic Diseases of Fish and Shellfish 3 (2+1)

Learning Objective (LO):

01:	To understand Principles of genetics and breeding
02:	To understand the process of Gene interactions, Linkage and crossing over
03:	To understand basic knowledge to population genetics
04:	To understand various Chromosome manipulation techniques
05:	To understand the History and present status of selective breeding in aquaculture

THEORY

Unit – I

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance complete and incomplete dominance, monohybrid and dihybrid ratios

Unit – II

Gene interactions dominant and recessive epistasis. Pleiotropism. Lethal genes. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over, Sex determination.

Unit – III

Introduction to population genetics. Hardy-Weinberg law and its significance. Quantitative genetics quantitative traits, polygenic traits, heritability. Mutation, Chromosomal structure and aberrations

Unit – IV

Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Cross breeding (hybridization) types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes.

Unit – V

History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

PRACTICALS

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt.

Course Outcomes

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

PO1:	To Gain knowledge about Gene and chromosome as basis of inheritance
PO2:	To understand Sex determination using chromosomes
PO3:	To understand Mutation, Chromosomal structure and aberrations
PO4:	To carry outcross breeding and hybridization in different fishes
PO5:	To understand Cryopreservation of gametes

Outcome Mapping

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

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

Total	12	15	6	12	9	9	15
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BFSC-603 Therapeutics in Aquaculture 2 (1+1)

Learning Objective (LO):

01:	To understand the scope of Biotechnology and its importance in fisheries/aquaculture
02:	To understand Genetic engineering or Recombinant DNA technology
03:	To understand various Molecular and immunological techniques
04:	To understand Biosensors .Concept of bioremediation of water
05:	To understand basics of Bioinformatics; Biological Databases and tools

THEORY

Unit – I

Introduction to Biotechnology scope and importance in fisheries/aquaculture, Nucleic acids - structure, function and types, Concepts of gene and genetic code, Operons. Structural organization of prokaryotic and eukaryotic cell. transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes;

Unit – II

Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology.

Unit – III

Molecular and immunological techniques PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism. DNA sequencing,

Unit – IV

Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting.

Unit – V

Introduction to Bioinformatics; Biological Databases and tools : Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

PRACTICALS

Study of structure of prokaryot and Eukaoryt Cells. Study on Model of protein Synthesis, Study of models rDNA Technology, Cell Culture, Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNA sequence analysis and comparison.

Course Outcomes

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

PO1:	To Gain knowledge about Gene regulation and expression in prokaryotes and eukaryotes
PO2:	To understand the applications of Recombinant DNA technology in vaccines production
PO3:	To understand the techniques of DNA sequencing,
PO4:	To have an idea about bioprocess engineering and bio prospecting.
PO5:	To understand Molecular visualization and Sequence analysis

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3		3	3		3
CO3	3	3	3	3	3	3	3

CO4	3	3	3	3	3	3	3
CO5	3	3		3		3	3
Total	15	15	9	12	9	12	15

BFSC-604 Fish Products and Value Addition 3 (2+1)

Learning Objective (LO):

01:	To understand fish preservation and processing methods
02:	To understand the importance water activity in relation to microbial growth
03:	To understand basic knowledge of Fish preservation by smoking
04:	To understand various methods of Marinated and fermented fish products
05:	To understand the Fish muscle structure

THEORY

Unit – I

Principle of fish preservation and processing. Processing of fish by traditional methods salting, sun drying, smoking, marinating and fermentation. Theory of salting, methods of salting wet salting and dry salting.

Unit – II

Drying and dehydration- theory, importance water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish.

Unit – III

Fish preservation by smoking- chemical composition of wood smoke and their role in preservation. Methods of smoking and equipment used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle technology in fish preservation and processing.

Unit – IV

Marinated and fermented fish products role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Fermented fish products of Southeast Asia. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc.

Unit – V

Fish muscle structure, myofibrillar protein and their role in elasticity formation. Extruded products theory of extrusion, equipment used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and breaded products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. and imitation products. HACCP in safe products production.

PRACTICALS

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinated products. Preparation of surimi and surimi based products. Preparation of diversified and value added fish products. Quality assessment of market sample of dried and fermented fish products.

Course Outcomes

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

PO1:	To Gain knowledge about Theory of salting, methods of salting wet salting and dry salting.
PO2:	To understand the Quality standard for salted and dry fish.
PO3:	To understand Hurdle technology in fish preservation and processing.
PO4:	To carryout methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko
PO5:	To understand Value addition to Diversified fish products

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
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CO1	3	3	3			3	3
CO2	3	3		3	3		3
CO3	3		3		3	3	3
CO4		3	3	3	3		
CO5	3	3		3		3	3
Total	12	12	9	9	9	9	12

BFSC-605 Fish Packaging Technology 2 (1+1)

Learning Objective (LO):

LO1:	To understand Importance of packaging in fish processing
LO2:	To understand the various Packaging equipment and machinery. Package design, evaluation and testing
LO3:	To understand basic knowledge about Laminations and Polymeric packaging
LO4:	To understand various Properties of packaging materials and their use
LO5:	To understand the Transport worthiness of packaging materials

THEORY

Unit – I

Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Printing for packaging and print identification.

Unit – II

Packaging equipment and machinery. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. Closures of packaging, heat seals bottle closure.

Unit – III

Laminations and co-extrusions. Polymeric Packaging. Retort pouch packaging - advantages and disadvantages. vacuum packaging, MAP, Biodegradable films, active packaging. Packaging requirements of fresh fish, frozen fish, canned Fish.

Unit – IV

Properties of packaging materials and their use in protective packaging with special reference to food. Principles of packaging fresh produce handling and transportation. Packaging for retail sale and storage.

Unit – V

Transport worthiness of packaging materials, accelerated shelf testing. Materials and their safe use in food contact application. Safety and legislation aspects of packing. Labelling and bar coding.

PRACTICALS

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

Course Outcomes

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

PO1:	To Gain knowledge about Printing for packaging and print identification
PO2:	To understand Closures of packaging, heat seals and bottle closure
PO3:	To understand various Packaging requirements of fresh fish, frozen fish canned fish
PO4:	To widely apply the knowledge of Packaging for retail sale and storage
PO5:	To understand Safety and legislation aspects of packing. Labelling and bar coding

Outcome Mapping

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

CO4	3		3	3			3	3	3	3	3	3
CO5	3	3	3	3	3	3	3		3		3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3		3	3		3
CO3	3		3		3	3	3
CO4		3	3	3	3	3	3
CO5	3	3		3		3	3
Total	12	12	9	9	9	12	15

BFSC-606 Quality assurance of Fish and Fishery Products 3 (2+1)

Learning Objective (LO):

LO1:	To understand the Importance of quality
LO2:	To understand the various Waste management in seafood processing
LO3:	To understand basic knowledge about Standards for sea foods
LO4:	To understand various Executive instructions on fish and fishery products
LO5:	To understand the Factors of National and international legislation on labelling

THEORY

Unit – I

Importance of quality, definitions and terminologies. Quality dimensions of seafood sensory, intrinsic, quantitative and affective parameters. Pre-harvest and post harvest factors affecting quality . Assessment of quality changes in fresh and iced fish. Quality changes during processing.

Unit – II

Prerequisites to HACCP. Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen, canned, cured, irradiated, cooked and chilled,

modified atmosphere packaged and freeze dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. The HACCP for seafood industries and protection of food from adulterants. Waste management in seafood processing. Assessment of food safety programmes.

Unit – III

Food laws and standards, national and international legislation, mandatory and non mandatory standards. Standards for sea foods - FDA, ISO, FSSAI, GOI notifications on fish and fishery products. International regulatory framework for fish safety and quality. General requirements for export of fish and fishery products to the EU.

Unit – IV

Role of export inspection council & export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products. Legislation for export quality assurance in India. Certification system for fish & fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish & fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues.

Unit – V

Labelling for product traceability. Labelling requirements - National and international, legislation on labelling. Components of traceability. Code-nutrition facts and nutrition labelling. Specific requirements of nutrition labelling. Food meant for specific age group and convalescing people. EU legislation on traceability of fish and fish products. Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability.

PRACTICALS

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

Course Outcomes

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

01:	To Gain knowledge about Quality changes during processing
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02:	To understand Assessment of food safety
03:	To understand General requirements for export of fish and fishery products to the EU
04:	To understand Interpretation of test reports and limits
05:	To understand Use of additives in seafood processing as quality enhancers

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3			3	3
CO2	3	3			3		3
CO3	3		3		3	3	3
CO4		3	3	3		3	3
CO5	3	3		3		3	3
Total	12	12	9	6	6	12	15

BFSC-607 Fishing Technology 2 (1+1)

Learning Objective (LO):

01:	To understand the Structure of various commercial fishing gears.
02:	To understand the various types of Trawling

03:	To understand basic knowledge about Types of gill net
04:	To understand various methods Constructional details of Line fishing
05:	To understand the types of Deck equipments

THEORY

Unit – I

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements. Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories thimbles, shackles, C-links, rings, G-links, Kellys eye, stopper, bottle screw, Deck layout of different fishing vessels.

Unit – II

Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid water trawling. Constructional details of single boat purse seine; two boat purse seine and method of operation.

Unit – III

Types of gill net constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom, mid water and pelagic gillnetting.

Unit – IV

Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole & line and trolling line. Operation of long line: set and drift long lining: bottom, mid water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch reducing devices.

Unit – V

Deck equipments types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

PRACTICALS

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook & line.

Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

Course Outcomes

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

01:	To Gain knowledge about Deck layout of different fishing vessels.
02:	To understand Constructional details of single boat purse seine; two boat purse seine and method of operation. .
03:	To understand Operation of gillnet
04:	To understand the Selectivity in fishing gear and by catch reducing devices.
05:	To understand Fishing equipment

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3		3	3	3
CO2	3	3		3	3		3
CO3	3		3		3		3
CO4	3	3	3	3	3	3	3
CO5	3	3		3		3	3
Total	15	12	9	9	12	9	15

BFSC-608 Navigation and Seamanship 2 (1+1)

Learning Objective (LO):

01:	To understand the Principles of navigation
02:	To understand the various Types of marine charts
03:	To understand basic knowledge about International code of signals
04:	To understand the Principles of seamanship
05:	To understand and Prepare vessel to face heavy weather and Temporary repairs for leaks constructions

THEORY

Unit – I

Principles of navigation terms and definitions, finding positions and method of position fixing magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay pointspelorus and azimuth mirror, method of observation. Sextant -parts and functions, finding adjustable and non-adjustable errors and principles and use. Hand lead line construction and markings and method of taking soundings. Types of speed logs patent log, impeller log.

Unit – II

Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions. The IALA-buoyage systems, cardinal and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching.

Unit – III

International code of signals, flag signals mars code and storm signals general system, brief system and extended system, storm signals stations Indian coasts, Fog signals, types and methods. Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS

Unit – IV

Principles of seamanship- Causes fire at sea, fire prevention on board the vessel and method of fire fighting at sea and recommended fire fighting appliances, Life saving appliances life jackets, life buoys and method of operations and contents, SART and EPIRB.

Unit – V

Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law. Preparing vessel to face heavy weather. Temporary repairs for leaks constructions of steering system and rigging emergency jury rudder .types of anchors and their applications. selection of suitable anchorage , procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust , transverse thrust mooring and securing the vessel to the jetty rigging fenders and gangways , and method of leaving vessels from the birth.

PRACTICALS

Anchoring, coming alongside the berth and leaving, practicing the different types of knots and wire splices, use of magnetic compass, GPS, Echo-sounder. CHART WORK-Finding positions by latitudes and longitudes by position lines by cross bearing, horizontal sextant, angles, vertical sextant angle and by running fix, finding position by speed, distance and time findings set and drift of current and findings course made good speed made good and steering course and finding position by counter acting the current observation of RADAR.

Course Outcomes

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

01:	To Gain knowledge about finding adjustable and non-adjustable errors
02:	To understand different buoyage systems.
03:	To understand about Radar, parts and functions of radar
04:	To operate and use Life saving appliances life jackets, life buoys
05:	To understand how to secure the vessel from storm

Outcome Mapping

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

CO4	3	3		3		3	3	3	3	3	3	3
CO5		3	3	3	3	3	3		3		3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3		3	3		3
CO3	3		3	3	3	3	3
CO4	3	3	3	3	3	3	3
CO5	3	3		3		3	3
Total	15	12	9	15	12	12	15

BFSC-609 Fisheries Administration and Entrepreneurship Development 2 (2+0)

Learning Objective (LO):

LO1:	To understand the principles of Public administration
LO2:	To understand the Different central and state level fisheries institutions
LO3:	To understand the Law relating to conservation and management of fishery resources in marine and inland sectors
LO4:	To understand the Concept of entrepreneurship
LO5:	To understand the Government schemes and incentives for promotion of entrepreneurship

THEORY

Unit – I

Introduction to Public administration, principles of organization and management of public enterprises, **Central and state responsibilities for fisheries development, Organizational set up of fisheries administration at the central and state levels. Present relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of department of fisheries, corporations and co-operatives.**

Unit – II

Different central and state level fisheries institutions. Role of Central and State Government in the regularity activities of Aquaculture and Fisheries. Implementation of community based

resource management plans. Historical review of fisheries development and management in India and world. International agencies/ organizations for promotion of fisheries worldwide. Fisheries legislation: overview of fisheries and aquaculture legislation in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries.

Unit – III

Law relating to conservation and management of fishery resources in marine and inland sectors. Recent changes in land forms. Land reforms legislation as applicable to Aquaculture. Judicial judgments relating to Aquaculture. Objectives, functions and authority of fishery regulatory agencies like Coastal Regulatory Zone (CRZ) AND Aquaculture Authority of India. Brackishwater aquaculture act, Marine fisheries policy, Laws relating to fish products and marketing. International Law of Seas and international commissions of fisheries and their impact.

Unit – IV

Concept of entrepreneurship; entrepreneurial and managerial characteristics; meaning an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; Generation, incubation and commercialization of ideas and innovations.

Unit – V

Government schemes and incentives for promotion of entrepreneurship. Preparation of enterprise budget for integrated fish farming. Fiscal and monetary policies and its impact on entrepreneurship. Infrastructural and other financial requirement for fishery entrepreneurship. Government policy on Small and Medium enterprises (SMEs) / SSIs. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of fisheries inputs industry. Characteristics of Indian fisheries processing and export industry.

Course Outcomes

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

D1:	To Gain knowledge about powers of functionaries of department of fisheries
D2:	To understand International environmental legislation and its impact on fisheries..
D3:	To understand the International Law of Seas and international commissions of fisheries and their impact.
D4:	To apply commercialization of ideas and innovations.

PO5:	To understand Characteristics of Indian fisheries processing and export industry.
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Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2		3		3	3		
CO3	3		3			3	3
CO4	3	3		3	3		
CO5	3	3		3		3	3
Total	12	12	6	12	9	9	9

BFSC-610 Fisheries Co-operatives, Marketing and Business Management 3 (2+1)

Learning Objective (LO):

LO1:	To understand the objectives of co-operative movement in fisheries in India
LO2:	To understand the marketing management and core marketing concepts
LO3:	To understand basic knowledge about Export markets and marketing of fish and fishery products
LO4:	To understand about fish business management

05:	To understand the Emerging trends in fish production, processing, marketing and exports.
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THEORY

Unit – I

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account

Unit – II

Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behavior and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India;

Unit – III

Export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification- export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector.

Unit – IV

Introduction to fish business management- Concept of management, management process (planning, organising, staffing, leading and controlling), Organizational behaviour, human resource planning, new dimensions in fish business environment and policies. Accounting procedures of fish business entity.

Unit – V

Emerging trends in fish production, processing, marketing and exports. Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs. Globalisation and the emerging business /entrepreneurial environment. Social Responsibility of Business.

PRACTICALS

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

Course Outcomes

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

PO1:	To Gain knowledge about Basic accounting procedures, profit and loss account
PO2:	To understand the functioning of Fish markets and other marketing infrastructure in India
PO3:	To understand Export and import policies relevant to fisheries sector.
PO4:	To operate Accounting procedures of fish business entity
PO5:	To understand Globalisation and the emerging business and the Social Responsibility of Business.

Outcome Mapping

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3		3	3		3
CO2		3		3			
CO3	3		3			3	3
CO4	3	3			3		
CO5	3	3		3			3
Total	12	12	3	9	6	3	9

CO-PO MAPPING SCORES

Courses Impact		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
1	BFSC 101	15	15	9	9	6	6	15
2	BFSC-102	9	0	9	9	3	9	6
3	BFSC-103	15	15	9	0	12	3	6
4	BFSC-104	0	12	0	6	0	0	9
5	BFSC-105	13	13	0	0	6	0	0
6	BFSC-106	0	0	9	0	9	0	4
7	BFSC-107	5	6	0	15	0	6	0
8	BFSC-108	7	15	3	14	0	0	0
9	BFSC-109	0	0	0	0	0	0	3
10	BFSC 201	15	0	0	2	0	0	9
11	BFSC 202	11	0	0	9	6	0	11
12	BFSC-203	9	3	5	0	6	0	0
13	BFSC-204	5	0	6	0	5	0	0
14	BFSC-205	9	0	3	2	0	0	6
15	BFSC-206	8	0	0	0	8	0	0
16	BFSC-207	9	2	0	6	9	0	0
17	BFSC-208	0	2	0	2	0	12	0
18	BFSC-209	0	0	3	0	0	0	3
19	BFSC-210*	0	0	0	3	0	3	
20	BFSC-301	12	9	9	9	15	09	06
21	BFSC-302	12	9	9	9	15	09	06
22	BFSC-303	15	15	09	09	09	09	09
23	BFSC-304	15	15	09	09	09	09	09
24	BFSC-305	09	12	09	09	15	12	09

25	BFSC-306	12	12	09	09	15	15	09
26	BFSC-307	15	15	09	09	15	15	09
27	BFSC-308	12	15	09	09	15	15	09
28	BFSC-309	12	12	09	09	15	15	09
29	BFSC- 401	15	15	9	9	15	15	9
30	BFSC- 402	15	15	9	9	15	15	9
31	BFSC- 403	15	15	9	9	15	15	9
32	BFSC- 404	15	15	9	9	15	15	9
33	BFSC- 405	15	15	9	9	15	15	9
34	BFSC- 406	15	15	9	9	15	15	9
35	BFSC- 407	15	15	9	9	15	15	9
36	BFSC- 408	15	15	9	9	15	15	9
37	BFSC- 409	15	15	9	9	15	15	9
38	BFSC-501	15	12	9	9	6	6	12
39	BFSC-502	12	15	9	12	9	6	15
40	BFSC-503	9	12	9	6	6	9	12
41	BFSC-504	12	12	9	6	6	6	9
42	BFSC-505	15	15	9	9	15	15	9
43	BFSC-506	12	12	9	6	6	6	15
44	BFSC-507	12	12	9	9	6	6	15
45	BFSC-508	12	12	9	12	6	12	15
46	BFSC- 509	12	12	9	9	6	12	12
47	BFSC-601	12	12	6	9	6	9	15
48	BFSC-602	12	15	6	12	9	9	15
49	BFSC-603	15	15	9	12	9	12	15
50	BFSC-604	12	12	9	9	9	9	12
51	BFSC-605	12	12	9	9	9	12	15
52	BFSC-606	12	12	9	6	6	12	15
53	BFSC-607	15	12	9	9	12	9	15

54	BFSC-608	15	12	9	15	12	12	15
55	BFSC-609	12	12	6	12	9	9	9
56	BFSC-610	12	12	3	9	6	3	9
Total Score		619	572	374	419	481	456	477