ANNAMALAI UNIVERSITY

FACULTY OF MARINE SCIENCES
ANNAMALAINAGAR

HAND BOOK

DEGREE COURSE
BACHELOR OF FISHERIES SCIENCE (B.F.Sc.)

2016 - 2020

ANNAMALAI UNIVERSITY
FACULTY OF MARINE SCIENCES, ANNAMALAI NAGAR

Academic Year From 2016-20
BACHELOR OF FISHERIES SCIENCE (B.F.Sc.) Course
Rules and Regulations, Curriculum and Syllabus

I. Title and Scope

1.1 These academic Regulations shall be called " Annamalai University, Faculty of Marine Sciences "B.F.Sc. Academic Regulations 2015" 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 2015 -2016 onwards

2. Definitions

2.1 University: University means Annamalai University, Parangipettai, 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 (1) 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 x8.5 = 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 (2015-2016 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 Training (IPT) and its Evaluation

Student who register of IPT during the 8th semester should have completed the ELP Programme 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 sixth semester for a period of 25days. 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	BFSc	8	16	169

7. Medium of Instruction

The medium of Instruction in Faculty of Marine 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 50^{th} and 60^{th} 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 course s 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, Record = 10 and Viva-voce = 5)	50
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 Credit Paper

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.

A. BFSC 509 Communication Skills (0+1)

The students will be evaluated for 100 marks. The course teacher will evaluate the performance and behavior of students in the classes and marks

Particulars	Max. marks
Attendance and routine activities	60
Behavior	15
Viva – voce & writing skill exercises	25
Total	**100**

B. BFSC 510 FIRST AID TRAINING (0+1)

The students will be evaluated for 100 marks. The course teacher will evaluate the performance and behavior of students in the classes and marks

Particulars	Max. marks
Attendance and routine activities	60
Behavior	15
Viva- voce & Evaluation by test	25
Total	**100**

C. BFSC 610 ALL INDIA STUDY TOUR (0 +1)

Educational tours for course BFSC 610 All India Study Tour are compulsory. The tours will be under taken during sixth semester. The duration of BFSE610 shall not exceed 14 days. The tours will be arranged by the department in consultation with the Dean, Faculty of Marine Sciences. The final examination will be conducted separately at the end of the semester by the University. The Marks for the tours are to be awarded as follows.

Particulars	Max marks	Evaluation by
Attendance	20	Accompanying staff
Behaviour	20	
Final Examination		
Tour Diary	20	By the organizing staff /
Tour record	30	Examiner
Viva – voce	10	
Total	**100**	

D. **BFSC 802 Physical Education (0+1)**

The students will be evaluated for 100 marks. The course teacher will evaluate the performance and behavior of students in the classes and marks

Particulars	**Max. marks**
Attendance and routine activities	60
Behavior	15
Participation in tournaments	25
Total	**100**

E. BFSC 803 SWIMMING (0+1)

The students will be evaluated for 100 marks. The course teacher will evaluate the performance and behavior of students in the classes and marks

Particulars	Max. marks
Attendance and routine activities	60
Behavior	10
Participation in Swimming, Kayaking & Scuba diving	30
Total	**100**

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)	Fill up the blanks @ ½ marks for 10 questions	5
ii)	True or False @ ½ marks for 10 questions	5
iii)	Match the following @ ½ marks for 10 questions	5
iv)	Choose the best answers @ ½ marks for 10 questions	5
v)	Short notes @ 3 marks for 5 questions	15
vi)	Short answer @ 5 marks for 3 questions out of 5	15
vii)	Essay type @ 10 marks for 3 questions out of 5	30
	Total	80

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 hours 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)	Fill up the blanks @ ½ marks for 10 questions	5
ii)	True or False @ ½ marks for 10 questions	5
iii)	Match the following @ ½ marks for 10 questions	5
iv)	Choose the best answers @ ½ marks for 10 questions	5
v)	Short notes @ 3 marks for 5 questions	15
vi)	Short answer @ 5 marks for 3 questions out of 5	15
vii)	Essay type @ 10 marks for 3 questions out of 5	30
	Total	80

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 less than 5**.50** 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 12.1 and 12.3. 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 so 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.

Who ever 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 alerted 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 169 course credits and shall have earned an overall grade point average (OGPA) of 5.50 out of 10 for all courses completed in BFSc 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.

15.1 Class 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 2015-2016.

The candidates under old semester system will, however, complete all the examinations with in 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.

Further, catering to the increasing demand of manpower will be produced through the B.F.Sc., course offered by the CAS in Marine Biology and it will be a great fillip to the fisheries sector, for promotions blue economy. Moreover, the growing demand of manpower in the Aquaculture sector could be met through this course, in addition to the seafood processing industry.

The Human resource developed through this course can help impart training on various capture and culture techniques to the local fisherfolk, thereby livelihood enhancement of the marginal coastal communities, in addition to prepare the fisherfolk for climate change adaptation through alternate livelihood options such as seaweed and ornamental fish culture.

More importantly, the graduates produced by this course are employable in the fisheries sector, in various capacities in different state, national, regional and international institutions and also private sectors, related to fisheries, aquaculture and sustainable coastal environment. These graduates an also became entrepreneurs in these sectors, providing with employment opportunities to the local people.

I. CURRICULUM

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 166 credits

Course Code	Semester/Course title	Credit hours
	I Semester	
BFSC 101	Taxonomy of Finfish	3 (1+2)
BFSC 102	Biology of finfish and Shellfish	3 (2+1)
BFSC 103	Fundamentals of Microbiology	3 (2+1)
BFSC 104	Fisheries Statistics	2 (1+1)
BFSC 105	Information and Communication Technology	2 (1+1)
BFSC 106	Freshwater Aquaculture	3 (2+1)
BFSC 107	Soil and Water Chemistry	3 (1+2)
BFSC 108	Aquatic Ecology and Biodiversity	3 (2+1)
	Total	**22 (12+10)**
BFSE 109	Physical Education (Non Credit Compulsory)	1 (0 + 1)
	II Semester	
BFSC 201	Taxonomy of Shellfish	3 (1+2)
BFSC 202	Anatomy of Finfish and Shellfish	3 (2+1)
BFSC 203	Limnology	3 (2+1)
BFSC 204	Marine Biology	3 (2+1)
BFSC 205	Fish Nutrition and Food Technology	3 (2+1)
BFSC 206	Culture of fish food organisms	2 (1+1)
BFSC 207	Aquaculture Engineering	3 (2+1)
BFSC 208	Principles of Biochemistry	3 (2+1)
	Total	**23 (14 + 9)**
BFSE 209	Swimming (Non-credit Compulsory)	1(0+1)
	III Semester	
BFSC 301	Physiology of Finfish and shellfish	3 (2+1)
BFSC 302	Ornamental Fish Production and Management	2 (1+1)
BFSC 303	Fish Genetics and breeding	2 (1+1)
BFSC 304	Oceanography and Meteorology	3 (2+1)
BFSC 305	Food Chemistry and fish nutrition	2 (1+1)
BFSC 306	Fish Canning and Packaging Technology	3 (1+2)
BFSC 307	Biochemical Techniques and Instrumentation	3 (1+2)
	Total	**18 (9 + 9)**
BFSE 308	Introduction to Environment Sciences (Audit Course compulsory)	3 (3 + 0)
BFSC 309	Communication Skills (Non Credit Compulsory)	1 (0 + 1)
	IV Semester	
BFSC 401	Inland and Marine Fisheries	3 (2+1)
BFSC 402	Microbiology of fish and fishery products	2 (1+1)
BFSC 403	Fish Products and by products Technology	4 (2 + 2)
BFSC 404	Pharmacology	3 (2 + 1)
BFSC 405	Freshwater Finfish and shellfish breeding and hatchery Management	3 (2 + 1)

BFSC 406	Fish Gear Technology	3 (2 + 1)
BFSC 407	Fisheries economics	3 (2 + 1)
BFSC 408	Disaster Management in Fisheries	1 (1 + 0)
	Total	**22 (14 + 8)**
BFSE 409	Rural Sociology and Psychology (Non-credit Compulsory)	1(0+1)
	V Semester	
BFSC 501	Coastal Aquaculture and Mariculture	3 (2+1)
BFSC 502	Marine Finfish and Shellfish breeding and hatchery management	3 (2+1)
BFSC 503	Fish diseases and Management	4 (2+2)
BFSC 504	Fisheries Marketing and Finance	3 (2+1)
BFSC 505	Fishing Craft Technology	2 (1+1)
BFSC 506	Navigation and Seamanship	2 (1+1)
BFSC 507	Fish population dynamics and stock assessment	3 (2+1)
BFSC 508	Fisheries Administration and Legislation	2 (2+0)
	Total	**22 (14 + 8)**
BFSE 509	First aid training (Non-credit compulsory)	1 (0 + 1)
	VI Semester	
BFSC 601	Fish quality assurance	2 (1+1)
BFSC 602	Fish freezing Technology	3 (2+1)
BFSC 603	Fisheries Biotechnology and bioinformatics	2 (1+1)
BFSC 604	Refrigeration and Equipment Engineering	3 (2+1)
BFSC 605	Introduction to fish Business Management	2 (1+1)
BFSC 606	Toxicology	2 (1+1)
BFSC 607	Chemotherapy and drugs in Aquaculture	2 (1+1)
BFSC 608	Aquatic Pollution and Coastal Zone Management	3 (2+1)
BFSC 609	Fisheries extension Education	3 (2+1)
	Total	**22 (13 + 9)**
BFSE 610	All India Study Tour (Non-credit Compulsory)	1(0+1)
	VII Semester	
BFSC 701	ELP in Aquafarming	10 (0+10)
BFSC 702	ELP in Fish Post Harvest Technology	10 (0+10)
	Total	**20 (0 + 20)**
	VIII Semester	
BFSC 801	In plant Training	20 (0 + 20)
	Total	**20 (0 + 20)**
	Grand Total	169 (76+93)

ANNAMALAI UNIVERSITY
CENTRE OF ADVANCED STUDY IN MARINE BIOLOGY
FACULTY OF MARINE SCIENCES
BACHELOR OF FISHERIES SCIENCES

SYLLABUS

ACADEMIC YEAR 2016 – 2020

I SEMESTER

BFSC 101. TAXONOMY OF FINFISH (1+2)

THEORY

UNIT I

Principles of taxonomy, Nomenclature, types, classification and interrelationships. Criteria for genetic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance.

UNIT II

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

UNIT III

Commercially important freshwater fishes of India and their morphological characteristics.

UNIT IV

Commercially important marine fishes of India and their morphological characteristics.

UNIT V

Other important groups of aquatic vertebrates. Introduction of modern taxonomic tools :karyotaxonomy, protein analysis and DNA polymorphism.

PRACTICAL

Collection and identification of commercially important inland and marine fishes. Study of their external morphology

and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA polymorphism; Visit to fish landing centres to identify commercially important fishes nd catch composition.

TEXT BOOKS

1. Nelson, J.S, 2006. Fishes of the World, 4th edition, John Wiley & Sons, Inc., Hobaken, New Jersy, 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.

BFSC 102. BIOLOGY OF FINFISH AND SHELLFISH (2+1)

THEORY

UNIT I

Food and feeding habits - Categories / classification of fish food - Fish food preferences - Major fish feeding types - Feeding adaptations in fishes - Detection of food by fishes - Feeding periodicity - Food and feeding habits of important finfish and shellfish species / groups.

UNIT II

Gut content analysis - Importance and limitations of gut content analysis - Feeding intensity - Methods of Gut Content Analysis.

UNIT III

Age and growth - Importance of studying age and growth in fishes - Growth model - Methods of age determination by using hard parts and by length frequency analysis.

UNIT IV

Reproductive biology - Different types / modes of reproduction in finfish and shellfish; primary and secondary sexual characters - Maturation and spawning - Different methods of estimation of fecundity - Various reproductive strategies - Parental care - Developmental stages in the life of finfish and shellfish species - General characteristics of eggs and larvae - Different types of eggs / larvae.

UNIT V

Marking and tagging techniques - Purpose of marking and tagging finfish and shellfish species - Group marking techniques - Individual external / internal marking techniques.

PRACTICAL

Analysis of gut contents. Study of food and feeding habits of finfish and shellfish. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking. Visit to shrimp and prawn hatcheries to study developmental stages.

TEXT BOOKS

1. Lagler, K.F., J.E. Bardach and R.R. Miller, 1962. Icthyology. John Wiley & Sons Inc., New York, 545 pp.
2. Carl E. Bond, 1979. Biology of Fishes. W.B. Saunders Company, Philadelphia, 514 pp.

3. Barrington, E.J.W., 1981. Invertebrate Structure and Function. 2nd Ed. The English Language Book Society & Nelson.
4. Biswas, K.P., 1996. A Text Book of Fish, Fisheries and Technology, II ED. Narendra Publishing House, Delhi, India, 396 pp.
5. Srivastava , C.B.L., 1999. Fish Biology. Narendra Publishing House, Delhi (India), 304 pp.

REFERENCE BOOKS

1. Ede, D.A., 1978. An Introduction to Developmental Biology. Blackie.
2. Diwan, A.P. and N.K.Dhakad, 2004. Embryology of Fishes. Recent Advances in Embryology Series-1. Anmol Publ.

BFSC 103. FUNDAMENTALS OF MICROBIOLOGY (2+1)

THEORY

UNIT I

Introduction and historical landmarks in the Development of Microbiology - Theory of spontaneous generation - Germ theory of Disease - Other significant developments in microbiology - Grouping and Description of living organisms. Prokaryotes, Structure and Function of Prokaryotic Cell - Prokaryotic Cell Structure - Structure and function of prokaryotes - Chemotaxis and Motility - Other Prokaryotes – Spirochaetes – Cyanobacteria – Rickettsiae - Archaebacteria (Archaea). Eukaryotic cell – Basic structure and organization of Eukaryotic cell in Comparison to Prokaryotic cell - Flagella and Motility in eukaryotes – Mitochondria – Chloroplasts – Nuclei - Endoplasmic reticulum (ER) and Golgi bodies - Golgi bodies - The cytoskeleton – Vacuoles - Differences between Prokaryotes and Eukaryotes. Eukaryotes – fungi, algae, protozoan – structure, classification characters and their economic importance. Viruses, structure, classification, characters and their economic importance.

UNIT II

Microscopy - Light Microscopy - Bright field microscope - Resolution of a microscope - Dark field Microscopy - Phase – contrast microscopy - Fluorescence Microscope - Electron Microscope, Sterilization and Disinfection - Red Heat - Dry Heat - Moist Heat - Filtration – Radiation - Ultra – violet (UV) radiation - Photodynamic sensitization - Ultrasonic and Sonic waves - Freezing - Chemical sterilization - Disinfection. Stains and Staining Reactions - Staining reactions - Simple staining - Differential Staining - Gram Staining – Principle - Endospore Staining. Microbial nutrition – Photoautotroph – photo-heterotrophs - Chemoautotrophs - Chemoheterotrophs - Chemical requirements - Organic growth factors - Physical requirements of growth. Microbial growth - Generation Time - The growth Curve - Continuous culture of microorganisms - Synchronous culture - Culture Media - Quantification of microorganisms / Measurement of cell numbers - Plating techniques - Membrane Filtration Technique - Indirect methods.

UNIT III

Energy yielding reactions - Biochemical pathways of energy production – Glycolysis - Pentose phosphate pathway – Respiration - The Krebs cycle - Electron transport chain - Summary of aerobic respiration - Summary of aerobic respiration. Fermentation and Biosynthetic Pathways - Biochemical Pathways of Energy Use (Anabolism) - Bacterial Photosynthesis. Enzymes - Enzyme Components - Mechanism of Enzymatic Action - Factors Influencing Enzymatic Activity. Microbial Genetics - Importance of microbial Genetics – Mutation - Genetic recombination or Gene Transfer – Transformation – Transduction - Transduction – Plasmids - Protoplasts and Spheroplasts

UNIT IV

Microbial ecology – Symbiosis – Mutualism – Syntrophism – Commensalism – Predation - Parasitism – Ammensalism - Competition. Aquatic microbial groups - Freshwater Microbiota - Estuarine microbiota - Marine

microbiota – Bioremediation. Role of microorganisms in the cycling of elements - Biogeochemical cycle - Nitrogen cycle - Nitrogen fixation – Ammonification – Nitrification – Denitrification - Phosphorus cycle – carbon cycle - Sulphur cycle - Decomposition of sulphur compounds - Microbial associated assimilation or immobilization - Oxidation and reduction of sulphur compounds. Water pollution and treatment - Sewage / waste water Treatment - Primary and secondary Treatment - Trickling filters. Bacteria of extreme environment – Deep sea and hydrothermal bacteria.

UNIT V

Immunology - General or Non specific host immune defence mechanisms - Characteristics of Immunoglobulin – Immunity - Immunological methods of detection of Microbial pathogens. Viral types and Diseases - Virus – Host Interactions - Viral interference and interferon - Control of viral infections. Pathogenicity and virulence - Diseases Classification - Portals of Entry: Transmission of infectious agents - Bacterial Human Diseases - Fungal human Diseases

PRACTICAL

Introduction to microscopy, wet mount and hanging drop preparations. Sterilization by different methods. Staining techniques – simple, differential and structural. Distribution of microorganisms in nature, isolation, pure culture and preservation methods. Enumeration of microorganisms. Environmental influences on microorganisms. Isolation of coliforms. Bioremediators and probiotics. Pathogens of aquatic animals – their isolation.

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.

BFSC 104. FISHERIES STATISTICS (1+1)

THEORY

UNIT I

Definition of statistics; Fisheries statistics, Basic concepts of population and sample, random sampling; Collection of data, census enumeration and sample surveys, their advantages and disadvantages, preparation of schedules and questionnaires.

UNIT II

Diagrammatic and graphical representation of data – bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and ogive.

UNIT III

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.

UNIT IV

Introduction to statistical inference, general principles of testing of hypothesis - types of errors. Tests of significance based on normal, t, chi-square and F distributions.

UNIT V

Bivariate data, scatter diagram, simple linear correlation, measure and properties; simple 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.

PRACTICAL

Construction of questionnaires and schedules, presentation of data using different diagrams and graphs, computation of different measures of central tendency and dispersion of fisheries data. Test of hypothesis based on normal, t, chi-square and F distributions. Simple correlation and regression. Fitting of length-weight relationship in fishes.

TEXT BOOKS

1. Box, G.E.P.,W. G. Hunter, and J.S. Hunter, 1978. Statistics for Experimenters. New York: John Wiley & Sons.
2. Cochran,W.G , and G. M. Cox, 1992. Experimental Designs. New York: John Wiley & Sons.
3. Lorenzen,T.J. and V. L. Anderson, 1993. Design of Experiments: A No-Name Approach. New York: Dekker.
4. Norman, R.,N. R. Draper, and H. Smith,1998. Applied Regression Analysis, 2nd ed. New York: John Wiley& Sons.
5. Hicks,C.R., and K. V. Turner, 1999.Fundamental Concepts in the Design of Experiments. Oxford University Press.

REFERENCE BOOKS

1. Winer, B.J.,D. R. Brown, and K. M. Michels, 1991.Statistical Principles in Experimental Design, 3 ed. New York: McGraw-Hill.

2. Neter,J. and W. Wasserman, 1996.Applied Linear Statistical Models, 4 ed. McGraw-Hill/Irwin,.
3. Conover, W.J., 1998. Practical Nonparametric Statistics Methods, 3 ed. New York: John Wiley & Sons.
4. Hollander, M, and D. A. Wolfe, 1999. Nonparametric Statistical Methods, 3 ed. New York: John Wiley & Sons.
5. Gupta ,S.P.., 2009.Statistical Methods , 8th edition, Jain book agency India.

BFSC 105. INFORMATION AND COMMUNICATION TECHNOLOGY (1+1)

THEORY

UNIT I

Information and communication technology and introduction to computers - ICT definition- importance – ICT for education – ICT for health - ICTs for empowerment and participation - ICTs and gender - ICTs and youth - ICTs for the environment. ICT for Societal Development: Institutions – Governments - Commercial Businesses - News and Media Organizations – Social. Basic components of computer: Input unit – processing unit – output unit – memory unit- arithmetic logic unit – control unit. Kinds of input units – kinds of output units – kinds of external storage units. Memory – features of memory – classification of memory.

UNIT II

Software - Definition of software – system software – application software – utility programmes – language translators – linker and loader programmes – application programmes. Programming languages: machine language- assembly language – procedure oriented language – high level languages. Programme execution modes: batch mode, on-line mode, time sharing mode, interactive modes – problem solving and algorithms. Operating system: functions – components of operating system - kinds of operating system.

UNIT III

Windows - version of Windows - feature of Windows. Components of Windows: Desktop – icons – My computer – Network Neighbourhood – Internet- recycle bin – taskbar – start button – turn off – run - help – search – settings – documents – programmes – word pad - closing windows. Menu – file – format – paint – clock – calculator – calendar - control panel – printer – date & time – mouse – display – screen saver – windows explorer.

UNIT IV

Data communication networks - Stand-alone and communication modes – telecommunication – data communication –– communication using modem - Computer networks: Local Area network, Wide Area Network, Metropolitan Area Network, intranet - Internet - Client-server networks - Peer-to-peer networks - Value-added networks - Network topologies: Hierarchical (or tree) topology - Linear bus (or horizontal) topology - Star topology - Ring (or hub) topology - Hybrid (or mesh) topology- Network Protocols and software - Network Applications: Bulletin board service (BBS) - Information services – Telecommuting -Teleconferencing - Workgroup computing - Electronic funds transfer (EFT) - Electronic data interchange (EDI) - Electronic commerce.

UNIT V

MS Office and fisheries softwares - The Word Processor - application of word processors – MS Word - MS PowerPoint – MS Excel – data analysis. Computer software for fisheries: Aquaculture price analysis – AQUAFarmer – POND – Aqua Assist System – shrimp/ fish pond management – aquaCalc – feed formulation software – fish vet – fish stock assessment.

PRACTICAL

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.

TEXT BOOKS

1. August E.Grant and Jennifer H. Meadows, 2010. Communication Technology update and fundamentals.(12th ed.2010). Focal press, 352 pp.

REFERENCE BOOKS

1. Measuring the Information Society: The ICT Development Index. International Telecommunication Union. 2009. pp. 108. ISBN 92-61-12831-9. http:// www.itu.int/ITU-D/ict/publications/idi/2009/material/ IDI2009_w5.pdf
2. William Melody et al., 2011.Information and Communication Technologies: Social Sciences Research and Training: A Report by the ESRC Programme on Information and Communication Technologies, ISBN 0-86226-179-1, 1986.

BFSC 106. FRESHWATER AQUACULTURE (2+1)

THEORY

UNIT I

Introduction to Aquaculture – Need for Aquaculture – Aquaculture in different habitat – Freshwater aquaculture – Global share of freshwater aquaculture in total aquaculture – Indian scenario-Tamilnadu scenario. Major species of freshwater aquaculture – Global level and Indian level-Production trends and prospects-Freshwater aquaculture resources – ponds – tanks-lakes – reservoirs.

UNIT II

Carrying capacity of pond- principles of culture fish production – Nursery ponds – Nursery phase of various culture species – Rearing ponds – growout ponds – pond preparation – pond management prestocking - management – control of aquatic weeds – control of weed fishes – control of predatory fishes – soil quality analysis – use of liming – Manure and

fertilizers application method and schedule – culture of fish food organisms in pond system /water cultivation technique.

UNIT III

Selection criteria of quality seeds – transportation technique of fish seeds – Acclimatization of seeds – Traits of important cultivable fish and shellfish.

UNIT IV

Culture methods – Indian major carps – Exotic carps – Minor carps – culture of air breathing fish species – culture of freshwater prawns- culture of coldwater fishes – culture of freshwater murrels culture of freshwater pearl producing mussel – freshwater pearl production technique – Quarantine ponds – Isolation ponds – composite fish culture.

UNIT V

Sewage fed fish culture – Principles of organic recycling of nutrients – Detritus based food chain – Use of agroindustrial wastes –Use of biofertilizers in aquaculture – Competition and compatibility among Indian and Exotic carps –Exotic fish species introduced in India and their impact – Economics of different culture species.

PRACTICAL

Study of cultivable species of finfish, shellfish. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Preparation and management of nursery, rearing and grow-out ponds. Study of effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shell fishes. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth.

TEXT BOOKS

1. Bardach, E.J., J.H. Rhyther and W.O. Mc. Larney, 1972. Aquaculture The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons.

2. Pillay, T.V.R., 1990. Aquaculture, Principles and Practices. Fishing News Book
3. Beveridge, M.C.M. and B.J. Mc Andrew, 2000. Tilapias: Biology and Exploitations. Kluwer.

REFERENCE BOOKS

1. Gilbert, B., 1990. Aquaculture. Vol II. Ellis Harwood.
2. Rath, P.K., 2000. Freshwater Aquaculture. Scientific Publ
3. Jayaram, K.C., 2006. Catfishes of India. Narendra Publ. House.

BFSC 107. SOIL AND WATER CHEMISTRY (1+2)

THEORY

UNIT I

Analytical Chemistry: Concept of volumetry -Standard solution, dilute solutions, units of concentration: standard curve and nomograph. Acids, bases and salts and their characteristics, hydrogen ions, concept of pH and buffer. **Water:** Chemistry of water: water molecule, properties of pure water and sea water. Composition of surface water, ground water and sea water; Dissolved gases; Factors affecting natural waters.

UNIT II

Water analysis: Collection and preservation of water samples. Measurement of temperature, transparency, turbidity, pH, electrical conductivity, salinity, chlorinity, total solids (TDS,TSS,TVS,TVDS); Determination of dissolved oxygen free CO2, total alkalinity, total hardness, calcium, magnesium, ammonia, nitrite, nitrate and phosphorus.

UNIT III

Soil characteristics: Soil origin, nature and formation of soils. **Physical properties of soil:** Soil texture, Soil structure, Soil colour, pore size, bulk density. water holding capacity; Soil types and their distribution. C**hemical properties of soil :** Soil

colloids, cation exchange, soil fertility and organic carbon : Nitrogen ratio; Soil reactions, soil acidity, soil alkalinity, conductivity, redox potential.

UNIT IV

Submerged soils: Peat soils, wet lands, fluxes between mud and water, methane and H2S, saline soils, alkaline soils, acid sulphate soils, iron pyrites and soil reclamation. **Soil and water amendments:** Amendments – lime, manure fertilizers, micronutrients, zeolites, alum, gypsum: environment amelioration – chlorination deodorizers, bacterial formulation

UNIT V

Soil analysis: Collection and preparation of soil samples: determination of soil texture, PH water holding capacity, conductivity: soil organic carbon, nitrogen, phosphorus lime requirement. **Soil and water quality criteria:** Soil and water quality criteria / requirement for aquaculture.

PRACTICAL

Principles of Titrymetry, Gravimetry, Potentiometry, Conductometry, Refractometry, colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. Dmonstration: 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 FreshwaterPonds. 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.

BFSC 108. AQUATIC ECOLOGY AND BIODIVERSITY (2+1)

THEORY

UNIT I

Definition: Ecological Hierarchy: Subdivisions of Ecology, Ecosystem: Principles and concepts. Examples of Ecosystems: The Pond, The Micro ecosystem: Production and Decomposition; Homeostasis of the Ecosystem, Definition; Laws of Thermodynamics.

UNIT II

Energy Environment; Energy flow, Concepts of Productivity; Measurement of primary productivity; Trophic

Levels, and Examples; Ecological Pyramids. Biogeochemical Cycles; Patterns and Basic types, cycling of organic nutrients; Pathways, Limiting factors and governing laws. Ecological Indicators.

UNIT III

Community Ecology; The biotic community, Ecological Dominance; community analysis; species diversity in communities; patterns in communities, ecotones, Population ecology; population group properties, population density and indices of relative abundance. Types of interaction – animal association- Symbiosis, commensalisms, parasitism, etc., Autoecology: Concepts of habitat and ecological Niche; Natural Selection; Artificial Selection.

UNIT IV

The freshwater environment and types: wetlands: dominant flora and fauna. Coastal Ecosystems, coastal zone and its classification. Estuaries: classification, physico-chemical factors; biota and productivity; example of some Indian estuaries. Mangroves: definition, mangrove plants, factors affecting distribution. Mangrove flora and fauna, mangrove afforestation.

UNIT V

The sea shore: The Inertial Zone, factors affecting life on shore, nature of substratum, physical factors, zonation, fauna and flora on a rocky shores, sandy shore, and muddy shore. Conservation of habitats: endangered species and their conservation, fish passes for migratory fishes, protected areas, marine parks and sanctuaries, Artificial reefs. Conservation programmes for endangered species.

PRACTICAL

Visit to a lake, natural pond\estuaries\swamp\ marsh\river\flood plain\reservoir and marine protected areas. Study of the habitat, biotic communities, and species diversity and their adaptive characters\associations. Visit to a mangrove forest, collection and identification of mangrove flora and

fauna. Visit to a rocky shore to study zonation and physico-chemical conditions. Collection and identification of Rocky shore flora and fauna. Visit to a sandy shore shore to study zonation and physico-chemical conditions. Collection and identification of sandy shore flora and fauna. Visit to a muddy shore to study zonation and physico-chemical conditions. Collection and identification of muddy shore flora and fauna. Collection and identification of corals and coral reef biota. Visit to marine structures on the coast, collection and identification of Borers and Fouler organisms, assessment of the damages and appraisal of remedial measures. Visit to a marine park/ sanctuary. Understanding the steps involved in protecting endangered habitats and species (Horse shoe crab, Marine turtles, sharks and marine mammals.)

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. PergamonPress.
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. Mc-Graw 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.

II SEMESTER

BFSC 201. TAXONOMY OF SHELLFISH (1+2)

THEORY

UNIT I

Study of external morphology and meristic characteristics of crustacean.

UNIT II

Study of external morphology and meristic characteristics of Mollusca.-Gastropoda, Monoplacophora, ,Amphineura.

UNIT III

Study of external morphology and meristic characteristics of Mollusca-Bivalvia, Cephalopod, Scaphopoda.

UNIT IV

Classification of crustacean up to the level of species with examples of commercially important species.

UNIT V

Classification of mollusca up to the level of species with examples of commercially important species.

PRACTICAL

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

TEXT BOOKS

1. Bal, D.V. and K.V. Rao, 1990. Marine Fisheries of India. Tata McGraw Hill Publishing Company Limited, New York, 472 pp.
2. Sahoo, D., 2001. Seaweeds of Indian coast. 283 pp. PPH publishers.

3. Isa bella A.Abbott, 2002. Taxonomy of economic seaweeds (pub.no.SG009) vol.I to VIII.

REFERENCE BOOK

1. Dhargalkar,V.K,X.N.Verlecar and V.Rathod, 2004.Seaweeds – a field manual NIO, Goa publication (1st Ed.)

BFSC 202. ANATOMY OF FINFISH AND SHELLFISH (2+1)

THEORY

UNIT I

External anatomy; Oral region and its associated structure; Digestive system and its associated glands - Cell structure, tissue and body organization - External anatomy of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish) - Oral region and its associated structures; digestive system and associated digestive glands of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish).

UNIT II

Circulatory System - Circulatory system of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish).

UNIT III

Respiratory and Skeletal systems - Respiratory system of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish) - Skeletal system of teleost / elasmobranch.

UNIT IV

Reproductive & Excretory systems (Urino-genital system) and Endocrine system - Reproductive and Excretory systems (Urino-genital system) of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish) - Endocrine systems of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish).

UNIT V

Nervous system and Sense organs - Nervous system of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish) - Sense organs of teleost; elasmobranch; crustacean (Eg. Palaemon prawn / penaeid shrimp), gastropod (Eg. Apple snail), bivalve (Eg. Freshwater mussel) and cephalopod (Eg. Cuttlefish).

PRACTICAL

Dissection of different shellfishes and finfishes to understand their internal organs – digestive, respiratory, excretory, nervous, circulatory and skeletal systems and also on sensory organs. Structure of endocrine glands.

TEXT BOOKS

1. Lagler, K.F., J.E. Bardach and R.R. Miller, 1962. Icthyology. John Wiley & Sons Inc., New York, 545 pp.
2. Carl E. Bond, 1979. Biology of Fishes. W.B. Saunders Company, Philadelphia, 514 pp.
3. Santhanam, R. Ramanathan and G. Jagadessan, 1990. Coastal Aquaculture in India.CBS Publication, India.

REFERENCE BOOKS

1. Jones, F.R.H., 1968. Fish Migration. Edward Arnold Ltd., London, 325 pp.
2. Milne,P.H.,1972. Fish and shellfish farming in the coastal waters Fishing News(Books) Ltd.London

BFSC 203. LIMNOLOGY (2+1)

THEORY

UNIT I

Introduction – Definition, Division, History, Development of Limnology, Early freshwater investigation; Inland water – Types, Identities and distribution, Lotic and lentic environments and their dynamics;Ponds, lakes, streams, rivers;Lakes – Origin, size, depth, Lake margins; Diversity; Famous lakes of the world and India.

UNIT II

Nature of inland water environments – Physical conditions and related phenomena; Morphometry, Physical features of water; Pressure, Compressibility, Density; Mobility, Buoyancy, Movements of water; Surface film, Temperature; Light, Colour of water, Turbidity; Chemical conditions and related phenomena – Dissolved gases, Dissolved solids; Dissolved inorganic solids, Dissolved organic matter; Hydrogen ion concentration – Acidity, Alkalinity, Neutrality; Biological relations – Influence of physical and chemical conditions on living organisms in inland waters: Shoreline; Productive volume, flotation phenomena, Body form adjustments; Relations of organisms to movements of water, surface film relations, temperature relations, light relations; Relations of dissolved oxygen, relations of carbon dioxide; Relations of other dissolved gases – Methane, Hydrogen sulfide; Nitrogen, Ammonia, Carbon monoxide, Dissolved solids, other elements, dissolved organic matter etc..

UNIT III

Plankton - Planktonic organisms, Classifications of plankton; Distribution of plankton – General geographic distribution; Horizontal distribution, Vertical distribution; Seasonal changes of body form in planktonic organisms; Food of planktonic organisms, Primary productivity; Aquatic plants – Character, Classification, Zonation, Seasonal relations; Quantity produced, Chemical composition, Distribution in different waters, Limnological role.

UNIT IV

Nekton – Composition, Distribution, movements; Benthos – Classification of benthic regions, Periphyton, Zonation, Distribution of benthos; Quantitative and qualitative movements and migrations of benthos, Seasonal changes in benthos, Origin and performance of profundal bottom fauna; Biological productivity – Circulation of food material, classification of lakes based on productivity; Laws of minimum, Biotic potential and environmental resistance, Quantitative relations in a standing crop; Trophic dynamics, Successional phenomena, Indices of productivity in Lakes, Artificial enrichment

UNIT V

Lotic environments – Running waters in general, Physical conditions; Water movements, Temperature, Turbidity, Light, Classifications of lotic environments; Biological conditions, Productivity features of lotic environments, Influence of currents, Plant growths; Plankton, Nekton, Benthos, Temporary and head water streams, General ecological succession.

PRACTICAL

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 freshwater phytoplankton; Enumeration and biomass estimation of freshwater phytoplankton; Estimation of primary productivity in fresh water bodies; Collection and identification of freshwater zooplankton; Enumeration and biomass estimation of freshwater zooplankton; Collection and identification of benthos from lakes and ponds, streams, canals; Enumeration and biomass estimation of benthos from lakes, ponds, streams and canals; Collection and identification of aquatic plants from different freshwater bodies; Methodology for collection and identification of bacteria in freshwater bodies; Enumeration and biomass estimation of bacteria in freshwater bodies.

TEXT BOOKS

1. Good, R.E., D.F. Whigham and R.L.Simpson, 1978. Fresh Water Wetlands: Ecological Processes and Management Potential. Academic Press.
2. Allan, J.D., 1995. Stream Ecology: Structure and Function of Running Waters. Chapman & Hall.
3. Dodds, W.K., 2002. Freshwater Ecology: Concepts and Environmental Applications. Academic Press.
4. Nath ,S. (Ed.)., 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation. Vol. VII. Narendra Publ. House.

REFERENCE BOOKS

1. Hynes, H.B.N.,1970. Ecology of Running Waters. Liverpool University, Press, Liverpool.
2. Mitsh, W.J. and J.G. Gosselink, 1996. Wetlands. John Wiley & Sons.
3. Pattern, B.C. ,1990. Wetlands and Shallow Continental Water Bodies. SPB Academic Press.
4. Hosetti, B.B., 2002. Wetlands conservation and management, 324 pp., Pointer, Jaipur.

BFSC 204. MARINE BIOLOGY (2+1)

THEORY

UNIT I

Division of marine environment; General account of major groups of phytoplankton Classification of diatoms and their reproduction; Classification of dinoflagellates and their importance; Major zooplankton groups.

UNIT II

Environmental factors affecting life in the ocean; Primary production and factors affecting primary production; Geographical and seasonal variation in plankton production; Marine food chains; Energy flow and food web, Marine food chains.

UNIT III

Vertical migration of zooplankton; Phytoplankton – Zooplankton relationship. Plankton and fisheries Benthos in rocky, sandy and muddy shore; Inter tidal ecology- Introduction; Ecology of rocky inter tidal zone; Ecology of sandy shore; Ecology of muddy shore; Mud banks.

UNIT IV

Mangroves; Seaweeds – classification and their uses; Coral reefs; Factors affecting coral reef distribution; Boring and fouling organisms; Nekton, outline - composition of nekton, habitats of nekton; Bioluminescence and indicator species; Red tides.

UNIT V

Biology, significance and classification in mammals; Adaptation in pinnipeds and cetaceans for breeding; Different communities of whales and their characteristic features; Adaptation in marine mammals for conserving body heat and submersion for long dive.

PRACTICAL

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

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. McCormick, J.M. and J.V. Thiruvathaakal, 1976. Elements of Oceanography. WB Saunders.
3. Balakrishnan Nair, N. and D.M.Thampy, 1980. A Text Book of MarineEcology. The MacMillan Co.
4. Castro, P. and M.E.Huber, 1997. Marine Biology. 2nd Ed. Mc-Graw 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.

REFERENCE BOOKS

1. Raymont, J.E.G., 1973. Plankton and Productivity in the Oceans. Pergamon Press.
2. Gross, G., 1993. Oceanography: A View of the Earth. 6th Ed. Prentice Hall.
3. Iversen, E.S., 1996. Living Marine Resources. Chapman & Hall.

BFSC 205. FISH NUTRITION AND FEED TECHNOLOGY (2+1)

THEORY

UNIT I

Introduction - Fish Nutrition -Nutrients and growth - Proteins and Amino acids-Structure and Composition- Chemical Properties- Classification- Protein Digestion and Metabolism- Lipids- Classification -Structure and composition- Fatty acid structure and classification- Phospholipids - Glycolipids- Waxes –Steroids –Cholesterol- Bile acids-Carbohydrates- Classification- Non-Sugars- Sugars-Vitamins, Minerals & Energy-Classification - Laws of thermodynamics -Energy units- Forms of energy-partitioning - Energy metabolism- Nutritional requirements of cultivable fish and shell fish.

UNIT II

Methods of Feed Formulation- Steps in feed formulation- Linear Programming-Quadratic programming- Feed Manufacturing- Receiving- Processing -Packaging Storage and Distribution -Feed Milling Processes - Grinding- Hammer mills- Attrition Mills- Horizontal Mixers- Vertical Mixer- Pelleting -Cooling and Drying- Crumbles-Extruder.

UNIT III

Different Forms of Feeds - Feeds based on life-cycle of fish- Product quality feeds- Larval feeds- Flakes- Farm-made

feeds -Feed additives- Binders- Antioxidants-Enzymes-Pigments-Growth promoters -Feed stimulants- Immunostimulants- Non-conventional feed ingredients and anti-nutritional factors-Digestive enzyme, digestibility and factors affecting digestibility- Protein digestion- Fat digestion- Carbohydrate Digestion- Microbial digestion- Factors affecting digestibility.

UNIT IV

Evaluation of feed- Storage of feed – Methods of Feeding- Feeding devices-Demand feeder- Electrically operated automatic feeders- Pneumatic-type automatic feeders-Hydraulic - type automatic feeders- Feeding carts- Feeding boats- Feeding devices for wet or moist feeds.

UNIT V

Feeding Management - Ration size- Feeding Tables-Factors affecting feed consumption- Sampling to monitor growth -Nutritional disorders- protein, lipid and mineral.

PRACTICAL

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.

REFERENCE BOOKS

1. Tom Lovell, 2009. Nutrition and feeding of fish. Springer.
2. Athithan, S., N. Felix and N. Venkatasamy, 2016. Fish nutrition and feed technology. Daya Publishing house.
3. Raghunath, M.R., 2013. Nutrition and feeding of fishes. Swastik Publications.
4. Pritimishra and Neera Jain, 2018. Practical manual on fish nutrition and feed technology. Daya Publishing house.
5. Athithan, S., N. Felix and N. Venkatasamy, 2006. Fish nutrition anf feed technology. Daya Publishing House.
6. De Silva, S.S. and T.A. Anderson, 2009. Fish nutrition in aquaculture. Chapman & Hall.

BFSC 206. CULTURE OF FISH FOOD ORGANISMS (1+1)

THEORY

UNIT I

Candidate species of phytoplankton and zooplankton as live food organisms of fresh water and marine habitats.

UNIT II

Biology and culture of microalgae- blue green algae-spirulina -green algae-diatoms-flagellates- harvesting and processing.

UNIT III

Biology- reproduction and feeding habits of zooplankton-culture requirements of important live feed organisms- infusoria-rotifers-cladocerans-tubifex.

UNIT IV

Artemia- biology- ecological significance- culture for cyst-biomass production-Culture-use of salt pans for artemia culture.

UNIT V

Culture of chironomids-Culture of earthworms-Bait fish and forage fish- Tropic potentials- of different fish food organisms- proximate composition of fresh water and marine species of live feed.

PRACTICAL

Methods of isolation and identification of different live feed organisms - Laboratory scale culture (batch and continuous) of selected live feed organism - Evaluation of live feed organisms - Decapsulation technique and hatching method of brine shrimp cysts.

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 Venkataramanujum, 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.

BFSC 207. AQUACULTURE ENGINEERING (2+1)

THEORY

UNIT I

Introduction to aquaculture engineering - Basics of the Aquaculture engineering – the need and the significance - Role of civil and mechanical engineering applications in aquaculture - Calculation and estimations –estimation of area and volume of different shapes.

UNIT II

Soil parameters, site selection and Surveying - Soil quality and its role in the success of the aquafarms - Soil

characters – their importance in the farming - Sampling methods and texture analysis. Classification of soil (based on particle size, chemical properties and biological nature) - Selection of a soil for aquafarm. Estimations and calculating earth work – ponds, dykes and other structures. Factors influencing the selection of sites for the coastal aqaufarms. List of site selection criteria - How the individual criterion influences the selection? - Factors that can be rectified and overcome in the farm operation - Tide fed and pump fed farms - Other types of coastal fish farming – farm designing and construction aspects - Different types of surveying and their uses - Interpretation of survey data and preparation of topo sketch - Tools used for the survey and their technical details - Trapezoidal rule and Simpson's rule.

UNIT III

Types of farms and their construction - Classification of farms - Based on source water - type of organism - method of culture - management aspects. Different models of aquafarms. (Coastal, freshwater, intensive and open water farms) - Coastal farms and seafarms - Semi-intensive and intensive farm designs. Cage and pen designs. Designing and construction of freshwater fish farms - Different structures in the farm (primary and secondary) - Positioning different structures - Bund classification - Designing of bund structures - Designing and construction of a complete farm - Location, designing and construction of hatcheries, race ways and nursery complexes - Different tanks- their design and construction.

UNIT IV

Water flow and control devices - Importance of water flow in aqua farms. Types of inlets and outlets = Design of sluices and gates - Merits and demerits of different water flow controlling devices. Water budgeting and distribution for aquafarms. How to calculate the water requirement for a fish farm? - Factors influencing the water volume in the farm - Types of pumps and their selection for aquafarm.

UNIT V

Mechanical units and Machineries - their application in farms - Water filtration devices and purification methods for aquafarms - Various filtration methods (Physical, chemical and biological methods) - Mechanical filtration devices - Filtration processes in the farm - Water transportation structures in an aquaf arm. Their design and construction - Importance of drain canals and drainage systems - Merits and demerits of different water transportation structures - Different pumps and their application in aqua farms - Types of pumps, principles and their use - Operation and maintenance aspects - Selection of pumps for the farms - Aerators, principles, classification and placement. Factors deciding the selection of aerators for the farm - Aeration process in aqua farm - Various types of aerators and their application in aqua farms - Operation, maintenance and placement of aerators – Considerations and implications.

PRACTICAL

Visit to aqua farms – Estimation of soil parameters – observation of soil qualities and seepage parameters - Contour survey and mappings - handling different valves – their operation – shutters and sluices - Designing of fresh and brackish water fin and shellfish farms - Designing of hatcheries - Estimation of construction parameters – determination of bund construction and other features of the ponds – Preparation of lay out of the farm - Cement and FRP nursery and hatchery units - Supply channel and drainage systems, gravitational flow – aerators – their operation and positioning - Estimations in the farm construction - Planning and designing of different farms.

TEXT BOOKS

1. Wheaton, F.W., 1977. Aquacultural Engineering. John Wiley & Sons.
2. Thomas, B.L., 1995. Fundamentals of Aquacultural Engineering. Chapman & Hall.
3. Ivar, LO., 2007. Aquaculture Engineering. Daya Publ. House.

REFERENCE BOOKS

1. Rath, P.K., 2000. Freshwater Aquaculture. Scientific Publ
2. Jayaram, K.C., 2006. Catfishes of India. Narendra Publ. House.

BFSC 208. PRINCIPLES OF BIOCHEMISTRY (2+1)

THEORY

UNIT I

Introduction to Biochemistry. Carbohydrate – Classification – monosaccharide, disaccharide, oligosaccharide, polysaccharide. Structure and properties of monosaccharide. Structure and function of polysaccharide – starch, glycogen, cellulose, chitin, pectins. Metabolism of carbohydrates – Digestion and absorption of carbohydrates, Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, Biological oxidation and electron transport chain.

UNIT II

Amino acids – structure and classification of amino acids, properties of amino acids – physical properties, stereoisomerism, optical activity, acid base properties, charges of amino acids. Reactions of amino acids with ninhydrin, sangers reagent, formaldehyde. Functions of amino acids. Proteins – Classification of proteins based on biological and chemical nature. Primary, secondary, tertiary and quaternary structure of protein. Properties and important reactions – amphoteric property. Metabolism of proteins – digestion and absorption of proteins, amino acid catabolism, synthesis of urea by urea cycle. Protein synthesis.

UNIT III

Lipids – classification and functions of lipids. Structure of lipids – simple and compound lipids. Fatty acids – classification – saturated and unsaturated fatty acids, essential fatty acids, eicosanoids. Digestion and absorption of lipids. Metabolism of fat and energy production – â oxidation of fatty acid.

UNIT IV

Nucleic acid – Structure of nucleic acid – ribonucleic acid (RNA), transfer RNA (tRNA), messenger RNA (mRNA), ribosomal RNA (rRNA), difference between DNA and RNA. Recombinant DNA and genetic engineering. Transcription – genetic code, Translation/Protein synthesis – activation of tRNA, elongation, termination. Mutation.

UNIT V

Enzymes – Classification, mechanism of enzyme action – lock and key model. Enzyme kinetics, isolation and purification of enzymes. Hormones – classification and mechanism of action of hormones. Vitamins – structure and function of fat and water soluble vitamins.

PRACTICAL

Glasswares, pH meter, Centrifugation, Filtration. Preparation of chemical solutions, standard solution. Preparation of cleaning solutions. Preparation of buffers. Estimation of protein by biuret method. Extraction of total lipids by Bligh and dyer method. Extraction of DNA. Determination of enzyme activity – protease, lipase and amylase.

TEXT BOOKS

1. Lehninger, A.L., 1984. Principles of Biochemistry. CBS.
2. Rodney, B., 1998. Concepts in Biochemistry. Cole Publ. Co.
3. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell, 2006. Harper's illustrated Biochemistry. Appleton & Lange.

REFERENCE BOOKS

1. NRC (National Research Council), 1993. Nutrient Requirements of Fish. National Academy Press, Washington.
2. De Silva, S.S. and T.A. Anderson, 1995. Fish Nutrition in Aquaculture. Chapman & Hall.
3. Lovell, R.T., 1998. Nutrition and Feeding of Fishes. Kluwer.

4. Berg, J.M., J.L. Tymoczko and L. Stryer, 2002. Biochemistry. WH Freeman.
5. Halver, J. and R.W. Hardy, 2002. Fish Nutrition. Academic Press.
6. Voet. D., J.G. Voet and C.W. Pratt, 2006. Fundamentals of Biochemistry. John Wiley & Sons.

III SEMESTER

BFSC 301. PHYSIOLOGY OF FINFISH AND SHELLFISH (2+1)

UNIT I

Physiology - introduction - The Hydrological Cycle or water cycle -Water as a habitat -Physical, chemical and biological properties - Biological Characteristics of water - Water as a major cell constituent.

UNIT II

Introduction - Solubility of gases -Gas diffusion and respiration of water - Classifications of respiration -Mechanism of respiration or Ventilation of gills -Double pump system - Fish blood as a gas carrier - Counter Flow Mechanism -Ram Ventilation - Oxygen dissociation curve -Carbon dioxide transported in the blood -Accessory respiratory organs in fishes - Physiology of respiration - Circulation - Introduction - General principles -Peristaltic pumps or Chamber pumps - Circulation pattern -Blood and Circulation-Cardio- vascular system - Working of the teleostean heart - Cardiac flow - Cardiac Vascular Control -Circulatory system of Cephalopods - Heart - Heart circulation -Circulatory system of Crustaceans - Circulatory physiology - Excretion Introduction - Excretory System functions - Internal structure of kidney - Mechanisms of excretion/ function - Shellfishes - Crustaceans - Mollusca - Osmoregulation - Introduction -Definitions -Osmoregulatory problem in freshwater fishes -Osmoregulatory problem in marine fishes - Osmoregulation in migratory fishes - Factors controlling osmoregulation in amphihaline fish.

UNIT III

Importance of reproductive physiological studies - Types of reproduction -Male reproductive system-Female reproductive system - Ovarian follicle - Oogenesis -Sexual differentiation -Maturation and spawning - Modes of reproduction -Hormonal control of reproduction -Life histories vary from the simple to the complex within the different groups of Crustacea-Hormones involved in reproduction and their sources transaction of external signal - Muscle physiology - Structure of various muscles -Smooth muscle or non striated muscle - Muscle metabolism and function -Composition and metabolism of dark and white muscle -Specialized muscles - Sound producing muscle - Sense organs - Introduction - Chemoreception -Electro-reception -Photoreception/vision - Pineal gland.

UNIT IV

Introduction - Nutrition and metabolism in fish - Pathways of cellular metabolism - Metabolic Rate -Nutrition Overview - -Nitrogenous compounds - Nitrogen Balance - Digestion - Metabolism -Metabolic pathways in fish - Metabolic rate - Standard and Active metabolism - Energy expenditure in stressed fish.

UNIT V

Metabolism and activity - Categories of stress - Action of stresses - Stress in defence mechanism - Structure and functions of important endocrine glands - Introduction - Major endocrine glands - pituitary gland - Neuro-endocrine regulation of the pituitary gland - The thyroid gland - Functions -urophysis (Caudal neurosecretory system) - Gonads - Gastro-Intestinal hormones - Pineal gland - Pheromones.

PRACTICAL

Estimation of oxygen consumption in fish - Estimation of carbon dioxide output in fish - Estimation of respiratory quotient in fish - Estimation of ammonia output in fish - Estimation of ammonia quotient in fish - Blood collection from

finfish - Blood collection from shellfish - Red blood cell differentiation and counting - Histology techniques – collection and fixation of specimens - Histology techniques – Processing and sectioning - Histology techniques – different kinds of staining - Histochemistry of pituitary glands - Influence of temperature on metabolic activity of fish - Influence of salinity on metabolic activity of fish - Estimation of chloride content in body fluids.

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
3. Matty, A.J., 1985. Fish Endocrinology. Croom Helm.
4. Thomas, P.C., S.C. Rath and K.D.Mohapatra, 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.
5. Mente, E., 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publ.
6. Nikolsky ,G.V., 2008. The Ecology of Fishes. Academic Press
7. Maria, R.J., A. Augustine and B.G.Kapoor, 2008. Fish Reproduction. Science Publ.

REFERENCE BOOKS

1. Bell ,T.A. and T.A.Lightner, 1988. A Handbook of Normal Penaeid Shrimp Histology. World Aquaculture Society.
2. Ghosh, R,. 2007. Fish Genetics and Endocrinology. Swastik Publ. & Distr.
3. Agarwal, N.K., 2008. Fish Reproduction. APH Publ.

BFSC 302. ORNAMENTAL FISH PRODUCTION AND MANAGEMENT (1+1)

THEORY

UNIT I

Introduction-Benefits of ornamental fish keeping as a hobby-Origin of keeping ornamental fishes as pets-Status of ornamental fish farming in India-Commercially important ornamental fishes - exotic species-Indigenous species-Marine Ornamental fishes.

UNIT II

Different types of fish tanks-Materials required for construction of tanks-Construction of all glass aquarium glass tank- Steps involved in setting up of aquarium-Equipments and accessories needed for small scale unit-Equipment and accessories needed by large scale ornamental fish production unit-Aerator- Filters- Types of Filter-Canister filter (external or internal type)-Trickle filter Resource-Submersible power filter (box filter / corner filter) - Uses of Aquatic plants-Types of plants- Important aquarium plants.

UNIT III

Water quality management- Temperature- pH-Chlorine-Hardness- Carbon di oxide-Dissolved Oxygen- Live food organisms-Feeds of fry- Infusoria- Daphnia- Tubifex-Blood worms- Mosquito larvae- Live food feeders – Artificial feed - Types of feeds-Preparation of Artificial feed.

UNIT IV

Breeding of live bearers- Introduction- Sex identification- Conditioning of parent fish- Breeding- Breeding of egg layers- Egg-scatterers -Egg-depositors- Egg-burriers - Mouth-brooders Nest-builders- Stimulating spawning- Fry rearing.

UNIT V

Diseases of ornamental fishes- Bacterial diseases - Protozoan diseases- Fungal diseases- Parasitic diseases-

Selective breeding- Selection- Crossbreeding -Hormonal induction of sex reversal- Quarantine- Transportation of ornamental fish- Fish packaging system- Ornamental fish trade.

PRACTICAL

Identification of common ornamental fishes - Identification of common ornamental plants —Fabrication of all glass aquariums -Setting up of aquariums -Aquarium accessories and equipments -Conditioning and packing of ornamental fishes -Feed preparation – Culture of live food organisms- Breeding of live bearers -Breeding of egg layers - Identification of ornamental fish diseases.

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. Er Hunnam, 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.

BFSC 303. FISH GENETICS AND BREEDING (1+1)

THEORY

UNIT I

Introduction to genetics - History of genetics - Genes - Evidence that genes are made of DNA (or sometimes RNA) - The chemical nature of Polynucleotides - DNA structure - X-ray diffraction - Base pair analysis - The Double helix - A variety of DNA structures - Activities of genes - Chromosomes - Introduction Resource - Structure of a chromosome Chromosome classification by centrometic position - Fish chromosomes - Sex chromosomes in fishes - - Polyploidy in fishes - Genetic significance of chromosomes - Meiotic Division. Mendelian genetics - Mendel's law of inheritance - Mendal's law of inheritance - Dihybrid cross - Significance of Mendel's laws - Examples for dihybrid inheritance in fishes - Back cross and Test cross - Dominant and recessive - Phenotype - Allele - Genotype - Homozygous - Locus - Punnet square - Pure line. Interactions of genes - Types of genetic interactions - Epistasis - Dominant and recessive Epistasis - Pleiotropism Examples for pleiotropism in fishes - Dominance - Incomplete dominant gene action - Codominant alleles - Additive gene action - Lethal genes - Dominant lethal genes - Recessive lethal genes - Semi-dominant lethal gene - Sex-linked lethal gene - Multiple Alleles - Complementary genes or duplicate recessive genes (9:7). Sex determination - Physiological sex and Gonadal sex - Gonochorism - Hermaphroditism - Parthenogenesis - Polygenic determination of sex - Sex determination mediated by sex chromosomes - XX~:XY~ – system. - ZZ~ :WZ~ – system - WXY - system - XO – system & ZO - systeme - Multiple sex chromosomes - Autosomal sex-determination - Metagamic sex determination - Secondary sexual characteristics Resource - Sex Linked genes - Sex linked genes - Y-Linked genes Resource - X-Linked Genes - Sex-limited traits - Sex influenced genes Resource - Sex-linked inheritance in the Platy - WZ/ZZ system.

UNIT II

Hybridization - Hybridization in fishes - Combining traits of different species - Sterility - Producing monosex fishes - Heterosis - Genetic basis of heterosis - Disease Resistance - Hybridization in carps - Interspecific hybrids - Intergeneric hybrids - Triploid mrigal - common carp hybrid - Chinese carp hybrid - Hybridization between catfishes - Interspecific hybridization of the tiger prawns - Hybridization among freshwater prawns - Introgressive hybridization - Methods for identification of hybrids - Hybrids for aquaculture. Mutation - Mutation - Chromosome mutations - Mutations caused by changes to ploidy level - Polyploidy - Polyploidy in fishes - Chromosomal aberration - Gene Mutations Resource - Induced mutation - Mutagens - Chemical mutations - Mutation hotspots . Linkage and crossing over - Types of linkage - Incomplete Linkage - Crossing over- Sex chromosomes and colour patterns - Chromosome mapping - Genetic distance - Fish .

UNIT III

Chromosome manipulation - Methods of chromosome manipulation - Shock treatment Resource - Detection of polyploid individuals - Androgenesis - All male production - Gynogenesis - Irradiation of spermatozoa - Diploidization - Application of gynogenesis in aquaculture - Polyploidy - Heterogeneous polyploid - Tetraploids - Polyploidy in shellfishes. Cryopreservation - Methods followed in cryopreservation - Quality evaluation of milt - Preservation - Non cryogenic preservation (short-term) - Cryogenic preservation (long term) - Protocol for cryopreservation - Equilibration - Ampouling - Labeling of straws, goblets and canes - Freezing - Storing - Thawing - Cryopreservation of eggs and embryos - Liquid nitrogen safety precautions - Vitrification - Importance of cryopreservation.

UNIT IV

Population genetics - How are allele frequencies estimated? - Hardy - Weinberg law - Proof of H-W Law - Derivatives - Forces changing gene frequency in population -

Mutation - Migration - Selection - Small populations - Genetic drift - Consequences of random genetic drift - Change of gene frequency due to sampling . Quantitative genetics - Genetics of qualitative and quantitative phenotypes - Qualitative traits - Quantitative phenotypes - Correlated traits - Heritability - Properties of heritability - General combinig ability - specific combining ability - Heterosis or hybrid vigour - Phenotypic value - Genotypic value - Environmental deviation - Average effect of gene - Breeding value.

UNIT V

Inbreeding - Inbreeding and its consequences - Use of inbreeding - Line Breeding Resource - Inbreeding depression - Inbreeding studies in fish - Simple measures to avoid inbreeding. Selective breeding - Breeding goals - Base population - History of selective breeding programme in aquaculture - Selection methods - Cross breeding (Intraspecific crossbreeding) - Cross breeding in common carp - Cross breeding in Tilapia - Cross breeding in catfishes - . Cross breeding in grass carp - Heterosis - Individual or mass selection - Limitations in individual selection - Family selection - Between-family selection - Within family selection - Combined selection - Progeny testing - Selection for more than one phenotype - Tandem selection - Independent culling - Selection index - Mating designs - Random Mating - Simple Paired Mating - Factorial Mating - Diallel Mating. Domestication - Domestication in fishes - Domesticated farmed species - The Domestication of Common carp - Domestication of channel catfish - Domestication in tilapia - Rainbow trout and other salmonids - Chinese carps - Indian major carps - Domestication of farmed shrimp - The Goldfish - Other domesticated fishes - Fish seed certification and quarantine procedures - Hatchery management - Fish seed quality assurance - Fish seed certification - What is quarantine? - Implementation of quarantine in developing countries - re-border measures - Use of specific pathogen free (SPF) stocks - Lists of approved species - Lists of approved exporting countries - - Preshipment treatment - Inspection, certification and compliance audits — General principles of quarantine .

PRACTICAL

Problems on Mendelian inheritance, linkage and crossing over, monohybrid and dihybrid ration, epistasis, pleotropism. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Cryopreservation protocols, Quality evaluation of fish milt.

TEXT BOOKS

1. Das P and 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. SBS Publ.
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 Chimes.
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 .

BFSC 304. OCEANOGRAPHY AND METEOROLOGY (2+1)

THEORY

UNIT I

The earth and the ocean basin, distribution of water and land; relief of seafloor., 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 world, El Nino.

UNIT III

Physical properties of seawater, salinity and chlorinity, temperature, thermal properties of seawater, Colligative and other properties of seawater; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. 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.

UNIT IV

Chemistry of seawater: Constancy and composition; elements present in seawater; artificial seawater; dissolved gasses in seawater, CO2 system and alkalinity; inorganic

agencies affecting composition of seawater, distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factors influencing their distribution.

UNIT V

Nature of atmosphere, process of water cycle in the atmosphere, tropical cyclones-Hurricanes, hurricane warning.

PRACTICAL

Operation of oceanographic instruments, Nansen reversing water sampler, Bathy thermograph, Grabs, corers, current meters, tidal gauges, echo-sounder. Determination of DO, COD, Alkalinity, nitrates, phosphates and silicates in seawater.

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. Verlag Chemie.
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.

BFSC 305. FOOD CHEMISTRY AND FISH IN NUTRITION (1+1)

THEORY

UNIT I

Composition of fish – moisture, protein, lipids, minerals, vitamins. NPN compounds – Taste, odour and flavour components in fish. Stale fish odour and flavour. Carbohydrates – naturally occurring polysaccharides in food. Seaweed polysaccharide – agar, agarose, carrageneenan, alginic acid. Dietary fibre and its role in human nutrition. Browning reactions – Enzymatic and nonenzymatic browning, Caramelisation.

UNIT II

Proteins – Proteins in food – milk protein, egg protein, cereal protein, legume protein. Fish muscle proteins – Sarcoplasmic, myofibrillar and stroma protein- Chemical changes in muscle during contraction. Native and denatured proteins. Changes in proteins during heat treatment and processing. Functional properties of proteins – water binding capacity, water holding capacity, gel formation, emulsification, viscosity, foaming.

UNIT III

Lipids – Fatty acids – Saturated, monounsaturated and polyunsaturated fatty acid. Fish oils. Omega 3 fatty acids. Role of fish lipids in human nutrition. Lipoprotein – LDLP, HDLP, chylomicrons, cholesterol. Chemical properties – hydrolysis, hydrogenation, saponification, oxidation. Characterisation of fat – Physical tests – melting test, specific gravity, viscosity. Chemical tests - free fatty acid value, saponification value, iodine value, peroxide value, R/M value, Anisidine value, TBA value.

UNIT IV

Food additives – types and their chemical nature – enzymes, vitamins and amino acids, emulsifier, antimicrobial

additives, sequestrants, flavour enhancer, surface active compounds, non nutritive sweeteners, colour additives.

UNIT V

Nutritive value of foods. Energy value and their requirements. Measurement of energy - direct and indirect calorimetry. Water, electrolyte and acid base balance. Nutritional labelling. Protein supplements, essential and nonessential amino acids, essential fatty acids, fish oils. Protein quality tests - biological value (BV), Digestibility coefficients, Protein efficiency ratio (PER), Net protein utilization (NPU), pepsin digestibility, chemical score, nitrogen balance, RDA of protein.

PRACTICAL

Estimation of moisture, crude protein, fat, ash and carbohydrate in foods. Determination of energy value in foods. Estimation of crude fibre in foods. Estimation of saponification value, iodine value and acid number. Estimation of vitamin C, iron, phosphorus in foods. Estimation of sodium benzoate. Estimation of water holding capacity, solubility, foaming and viscosity.

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, 319 pp, 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 andFeeding 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.

BFSC 306. FISH CANNING AND PACKAGING TECHNOLOGY (1+2)

THEORY

UNIT I

Introduction to canning principle. Historical developments. Containers – can making materials and cans, characteristics of seam. Steps in canning – raw materials, preparatory treatments, precooking, packing, exhausting, seaming, thermal processing, cooling and storage.

UNIT II

Thermal processing – heat resistance of microorganisms, heat penetration, graphical method of formulation. Fo-value.

UNIT III

Canning of commercially important fishes, shellfishes and other food products – salient features. Retort pouch packing – principles and techniques; HTST process and aseptic packing – principle and technique.

UNIT IV

Spoilage of canned foods – physical, chemical and biological. Signs of spoilage – Flipper, springer, soft swell and hard swell. Spoilage manifestation in canned foods. Causes of spoilage and preventive measures. . Quality defects in canned foods – Honey combing, blackening, browning and blue discolouration, struvite formation, curd formation, mush formation in canned sardine, greening in tuna.

UNIT V

Introduction to food packaging – objectives and requirements. Characteristics of various packaging materials – metals, paper and paper board, corrugated fibreboard, plastics, multiplayer and testing of packaging materials and containers.

PRACTICAL

Type of cans, canning equipments and layouts of cannery. Canning of different varieties of fish and shellfish. Cut-out test of canned products. Examinations of can double scam. Heat resistance of bacteria. Heat penetration in canned food. Spoilage conditions in canned products. Familiarisation with various packaging materials and containers 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.

BFSC 307. BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION (1+2)

THEORY

UNIT I

Principles and applications of Spectrophotometry – UV-Vis spectrophotometer and its instrumentation.

UNIT II

Basic principles and applications of chromatographic techniques – LC - Gel filtration, Affinity chromatography, Ion exchange chromatography; Thin Layer Chromatography; Gas Chromatography; High Performance Liquid Chromatography.

UNIT III

ELISA – Components and Types - Direct, Indirect, Sandwich, Competitive; Radio isotopes - Radio Immuno Assay; Centrifugation – Types, Rotors - Ultracentrifugation.

UNIT IV

PCR – its components and application; Blotting-southern, northern, western techniques.

UNIT V

Plasmid isolation; Cell culture – Types and manipulations; Hybridoma technology; Cloning – Molecular, Cellular and Organism cloning.

PRACTICAL

Analysis of glucose, amino acids / proteins fatty acids/ lipids and RNA/DNA in fish tissues by spectrophotometry. Identification of amino acids by paper chromatography. Demonstration of blotting techniques and PCR. Sub-cellular fractionation by centrifugation.

TEXT BOOKS

1. Wilson, K. and Walker, J., 2002. Practical Biochemistry: Principles and Techniques. Cambridge University Press, Oxford.
2. Welch, P.S., 2003. Limnological Methods. Narendra Publ. House.
3. Clesceri, L.S., E.W. Rice, A.E. Greenberg and A.D. Eaton, 2005. Standard Methods for the Examination of Water and Wastewater. APHAAWWA-WEF, Washington DC.

REFERENCE BOOKS

1. Fishbein, L., 1973. Chromatography of Environmental Hazards: Metals,Gaseous and Industrial Pollutants. Elsevier.
2. Jeffery, G.H., J. Basset, J. Mendham and R.C. Denney (Eds.)., 1989. Vogel's Textbook of Quantitative Chemical Analysis. Longman.

3. Sparks, D.L., A.L. Page, P.A. Helmke, R.H. Loeppert, P.N. Soltanpour, M.A. Tabatabai, C.T. Johnston and M.E. Sumner (Eds.)., 1996. Methods of Soil Analysis: Part 3. Chemical Methods. SSSA-ASA, Madison.

IV SEMESTER

BFSC 401. INLAND AND MARINE FISHERIES (2+1)

UNIT I

Status of the Capture Fisheries of the World and India - Inland and Marine Environment - FAO's Major fishing areas of the world - Major fish species composition of the major fishery regions of the world - World inland/marine capture fisheries production - Problems and management of world inland fisheries - Inland and marine capture fisheries resources in India - Potential of Indian EEZ - Status of inland/marine capture fisheries production in India.

UNIT II

Major inland fisheries in India - Riverine Fisheries in India - Ecology, classification and fish production potential of rivers in India - Fish and fisheries of Himalayan/peninsular riverine systems in India - Impacts of dams on riverine fisheries - Impact of inter-river basin linkages on fisheries - Reservoir fisheries in India - Ecology, classification and fish production potential of reservoirs in India - Fish and fisheries of major reservoirs in India - Natural vs Man-Made lakes fisheries - Estuarine/Brackish water lake/Backwater Fisheries in India - Fish and fisheries of estuaries of the east and west coast of India - Fish and fisheries of major brackish water lakes and backwaters in India - Shellfish fisheries of brackish water bodies - Floodplain wetland fisheries in India - Ecology and classification of flood plain wetlands (Beels) of India - Fish and Fisheries of floodplain wetlands (Beels) in india - Cold water fisheries in India - Fish and fisheries of cold water bodies in India - Sport fisheries in India.

UNIT III

Major marine finfish fisheries in fisheries in India - Deep sea fisheries in I **UNIT IV**Major marine shellfish fisheries Molluscan fisheries in India. India - Pelagic fisheries in India - Demersal ndia.in India - Crustacean fisheries in India.

UNIT V

Conservation and management of capture fisheries resources in India - Introduction of exotic fish species and Impacts of exotic fish species on aquatic biodiversity in India - Conservation of inland and marine fisheries resources in India - Application of GIS and Remote sensing System in fisheries.

PRACTICAL

Visit to inland and marine fish landing centres; sampling, collection and familiarization of commercially important groups viz., marine and freshwater teleosts, elasmobranchs, crustaceans, molluscs and seaweeds; observation and analysis of marine catches by major crafts and gears; observation and analysis of species composition of commercial inland fish catches at landing and assembling centres; observation and experimental operations of selected fishing gears in inland / estuarine waters; Maintenance of records of marine and inland fish catch data; GIS and Remote Sensing in capture fishery.

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. Samuel, C.T., 1968. Marine Fisheries in India. Narendra Publ. House.
4. Kurian, C.V. and V.O.Sebastian, 1986. Prawns and Prawn Fisheries of India.Hindustan Publ. Corp.
5. Bal, D.V. and K.V. Rao, 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill.

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

BFSC 402. MICROBIOLOGY OF FISH AND FISHERY PRODUCTS (1+1)

THEORY

UNIT I

Introduction - History of microorganisms in foods; Role and significance of microorganisms in foods.

UNIT II

Parameters affecting microbial growth - intrinsic parameters and extrinsic parameters.

UNIT III

Microorganisms in fish – raw fish – chilled fish – frozen fish – cured fish - canned fish – fermented – irradiated - value added and other miscellaneous fish products.

UNIT IV

Study of food-borne pathogens involved in infective and intoxication type of food poisoning – Indigenous pathogens – *Vibrio parahaemolyticus, V. cholerae, Listeria monocyto genes, Clostridium*- Non-indigenous pathogens - *Salmonella, Shigella, Staphylococcus, E. coli.*

UNIT V

Other biological hazards like mycotoxins, parasites, viruses, marine toxins, etc. Faecal indicator organisms – Faecal coliforms, Faecal streptococci.

UNIT VI

Study of microorganisms in food by conventional and rapid techniques; Encapsulation – endospores, formation of cell aggregates.

PRACTICAL

Study of micro-organisms associated with finfish and shellfish. Spoilage microorganisms. Isolation of pathogenic bacteria associated with fish and fishery products - *Vibrio, E. coli, Salmonella, Listeria, Clostridium, Campylobacter, Staphylococcus,* Faecal *Streptococcus,* etc. Effect of chemical and physical preservatives on spoilage organisms. Conventional and rapid methods for detection of microorganisms. Biochemical tests for characterization of bacteria.

TEXT BOOKS

1. Kreuzer, R., 1971. Fish Inspection and Quality Control. Fishing News.
2. Anthony, T.T., 1988. Handbook of Natural Toxins. Marine Toxins and Venom. Vol. III. Marcel Dekker.
3. Connell, J.J., 1995. Control of Fish Quality. Fishing News Books.
4. Balachandran, K.K., 2001. Post Harvest Technology of Fish and Fish Products. Daya Publ. House.

REFERENCE BOOKS

1. Kreuzer, R., 1971. Fish Inspection and Quality Control. Fishing News Books.
2. Fennema, K., W.D. Powrie and E.H. Marth, 1973. Low Temperature Preservation of Foods and Living Matter. Marcel Dekker**.**
3. John DEV, 1985. Food Safety and Toxicity. CRC Press.
4. Huss, H.H., M. Jakobsen and J.Liston, 1991. Quality Assurance in the Fish Industry. Elsevier.
5. Hall, G.M. (Ed)., 1992. Fish Processing Technology. Blackie.
6. Gorbutt, J., 1997. Essentials of Food Microbiology. Arnold Hodder Headline Group.

7. Hui, Y.H., D.P. Merle and G.J. Richard (Eds.)., 2001. Food Borne Disease Handbook. Seafood and Environmental Toxins. Vol. IV. Marcel Dekker.
8. Gopakumar K. (Ed.)., 2002. Text Book of Fish Processing Technology.ICAR.
9. Kanduri, L. and R.A. Eckhartt, 2002. Food Safety in Shrimp Processing. Fishing News Books.
10. Huss, H.H., 2003. Assessment and Management of Seafood Safety and Quality. FAO Tech. Paper No. 444.
11. Vincent, K. and J.E.R. Omachonu, 2004. Principles of Total Quality. CRC Press.
12. Sen, D.P., 2005. Advances in Fish Processing Technology. Allied Publ.
13. Shukla, R.K., 2006. Total Quality Management Practicing Manager. New Royal Book.

BFSC 403. FISH PRODUCTS AND BY-PRODUCTS TECHNOLOGY (2+2)

THEORY

UNIT I

Principle of fish preservation and processing. Processing of fish by traditional methods – salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting – wet salting and dry salting. Drying and dehydration – theory, importance of 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 II

Fish preservation by smoking- chemical composition of wood smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle

technology in fish preservation and processing. Marinaded and fermented fish products – role of acids in marinades.

UNIT III

Fish and prawn pickles, fish sauce and fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibriller protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products.

UNIT IV

Fish meal and oil. Dry reduction and wet reduction methods. Fish maws, shark leather, chitin, chitosan, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach de mer. Utilization of seaweeds - agar agar, alginin, carrageenan.

UNIT V

Fish protein concentrate. Fish hydrolysate, partially hydrolysed and deodorised fish meat, functional fish protein concentrate and their incorporation to various products. Diversified fish products: battered and braided products – fish finger, fish cutlet, fish wafer and fish soup powder etc and imitation products. Value addition, HACCP in safe products production.

PRACTICAL

Preparation salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of fish manure, fishmeal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, fish glue, fish gelatin, chitin and chitosan. Preparation of fermented fish sauce and marinaded products. Preparation of seaweed products. Quality assessment of individual by-products.

Preparation of diversified and value added fish products - preparation of prawn & fish pickles - preparation of surimi and surimi based products.

TEXT BOOKS

1. Wheaton, F.W. and T.B.Lawson ,1985. Processing Aquatic Food Products. John Wiley & Sons.
2. Balachandran, K.K., 2001. Post Harvest Technology of Fish and Fish Products. Daya Publ.
3. Hui, Y.H., D.P. Merle and J.G. Richard (Eds.)., 2001. Food Borne Disease Handbook. Seafood and Environmental Toxins. Vol. IV. Marcel Dekker.
4. Sen, D.P., 2005. Advances in Fish Processing Technology. Allied Publ.
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REFERENCE BOOKS

1. Hall, G.M., 1992. Fish Processing Technology. Blackie.
2. Gopakumar, K., 2002. Text Book of Fish Processing Technology. ICAR.
3. Oefjen ,G., H .Wilhelm and Peter, 2004. Freeze Drying. Wiley-VCH GmbH & Co.

BFSC 404. PHARMACOLOGY (2+1)

THEORY

UNIT I

Introduction to pharmacology, pharmacological terms and definitions, sources of drugs. Introduction to considerations for appropriate use of drugs. Drug laws and regulations. Drug delivery routes and methods of application. Water area and dosage calculation. Storage and shelf life of drugs.

UNIT II

Principles and mechanism of drug action, pharmacokinetics. Absorption, distribution, biotransformation and excretion of drugs. Chemical pathways and substrates affected. Factors influencing drug metabolism. Synergistic, additive and antagonistic interaction. Functional analyses used in pharmacokinetics and role of the route of administration. Drug distribution, Bioequivalence and bioavailability.

UNIT III

Pharmacodynamics, concept of drug receptor, Receptors and drug-receptor interactions Quantitative aspects of drug-receptor interactions dose response relationship, (the dose-response curve), half-life and withdrawal period, threshold dose, therapeutic dose, maximal dose, toxic dose and lethal dose, factors affecting drug effect and dosage, principles of drug safety in terms of species and environment, efficacy of drugs. Factors affecting membrane transport of drugs Partitioning and transformations of drugs/chemicals in aquatic environment.

UNIT IV

Systemic pharmacology, Drugs acting on nervous system; anesthetics. Drug interactions, molecular mechanisms of drug action. Adverse effects of drugs, antibiotics residues. Recent advances in Pharmacology, Role of Biostatics, Pharmaceutical Industry, Drugs used in fish transportation.

PRACTICAL

Antibiotic residual assays; Studies on histopathololgical changes caused due to chemotherapy. Bioassays for clinical evaluation of drugs. Important anesthetics and their mode of action.

TEXT BOOKS

1. Brown KMT. 2000. Applied Fish Pharmacology. Aquaculture Series 3, Kluwer.

2. Noga EJ. 1996. Fish Disease, Diagnosis and Treatment. Mosby-Year Book.
3. Richard DH, Mary JM, Richard AH & Pamela CC. 2005. Pharmacology. Lippincott Williams & Wilkins.
4. Stoskopf MK. 1993. Fish Medicine. WB Saunders.
5. Anon. 2001. Food borne Disease Handbook. 2nd Ed. Vol. IV. Seafood and Environmental Toxins. Marcel Dekker.
6. Edward PR. 1984. Seafood Toxins. American Chemical Society, Washington, D.C.
7. Hashimoto Y. 1979. Marine Toxins and Other Bioactive Marine Metabolites. Scientific Society Press, Tokyo.
8. Moss J, Iglewski B, Vaughan M & Ju AT. 1995. Bacterial Toxins and Virulence Factors in Disease. Vol. VIII. Marcel Dekker.

BFSC 405. FRESHWATER FINFISH AND SHELLFISH BREEDING AND HATCHERY MANAGEMENT (2+1)

THEORY

UNIT I

Freshwater fish seed resources of the world – freshwater finfish seed resources of India – Freshwater fish seed resources potential and present production in Tamil Nadu – Natural breeding of finfish in freshwater ecosystems – Monsoon and breeding of finfish – Types of breeding in finfish & shellfish. Selection of riverine spawn collection sites – gears used for collection of finfish & shellfish spawn – Method for temporary storage of collected spawn – spawn quality and quantity indices – Advantages and disadvantages of wild seed collection from rivers.

UNIT II

Seed maturity and breeding season of various cultivable freshwater finfish & shellfish species – gonadal stages – gonad development and gamete development in male and female fish – Type of fish eggs and embryonic development

UNIT III

Methods of breeding of cultivable freshwater finfish & shellfish– Bundh breeding – Wet and dry bundh – Collection of eggs and hatching in bundh breeding – Factors influencing bundh breeding – Advantages and disadvantages of bundh breeding.

UNIT IV

Induced breeding of warm water cultivable finfish & shellfish species – Environmental factors affecting spawning and breeding – Hypophysation of fishes – Fish pituitary gland – its structure, collection, preservation and preparing of pituitary extract and injecting – Dosage calculation of pituitary extract and administration – Brood stoke management and transportation of brood fish – Synthetic hormones used for induced breeding of carps.

UNIT V

Different types of freshwater fish hatcheries – traditional, Chinese, glass jar and modern controlled hatcheries – causes of mortalities of eggs and spawn – Treatment of eggs – spawn rearing techniques – use of anesthetics in fish breeding and transport – Breeding techniques for Indian Major Carps, Exotic carps, Mahseer, Trout, Tilapia, Catfishes – Multiple breeding of carps – Cryopreservation of freshwater fish gametes.

PRACTICAL

Selection of breeders of carps and catfishes. Collection and preservation of pituitary glands in freshwater fin fish & shellfish fishes. Preparation and administration of pituitary gland extract. Use of synthetic compounds for induced breeding of freshwater finfish & shellfish fishes. Study of hatchery technology of freshwater & shellfish fishes. Care of eggs, spawn and fry. Identification of eggs and larvae of common cultivable freshwater fin fish & shellfish fishes. Detailed study of design and operation of Chinese circular hatchery and funnel shaped hatchery. Study of seed production technology of Indian carps/cat fishes, tilapia.

TEXT BOOKS

1. Rajendra Kumar Rath, 2000. Freshwater aquaculture. Scientific Publishers, Jodhpur, India.
2. Santhanam, R., N. Sukumaran and P. Nataraj, 1999. A manual of freshwater aquaculture. Oxford and IBH Publishing Co. Pvt. Ltd., N ew Delhi.
3. Biswas, K.P., 1996. A text book of fish, fisheries technology, 2nd edition. Narendra Publishing House, Delhi.
4. Khanna, S.S. and H.R. Singh, 2003. A text book of fish biology and fisheries. Narendra Publishing House, Delhi.
5. Pillay, T.V.R. and M.N. Kutty, 2012. Aquaculture principles and practices. 2nd edition. Blackwell Publishing Wiley India Pvt. Ltd.

BFSC 406. FISHING GEAR TECHNOLOGY (2+1)

THEORY

UNIT I

Introduction; classification of fishing gears of world and India; Factors that determine selection of fishing gears. Gears used in relation to fish and fishing area; FAO classification of fishing gears and methods.

UNIT II

Types of gear material - Classification – natural and synthetic- yarns, twines, ropes – their properties and identification methods, meshes, Braiding, Netting – types of knots, knotless netting, braiding ropes, floated ropes. Yarn numbering system - Direct system, indirect system-Tex , Denier, Metric systems; inter conversions, Runnage; Twist in twines and ropes; effect of twist. - Care maintenance of fishing gears - Maintenance and storage of gears and gear materials-different preservation methods.

UNIT III

Shaping of webbing by braiding , baiting, All bar braiding-fly mesh- Shaping of webbing by cutting -tailoring, N

cut, T cut ; mounting of webbing – different methods, hanging coefficient, take up ratio; joining-assembling of nets.

UNIT IV

Accessories for fishing gear. Floats – buoys – materials, types, properties and buoyancy; Sinkers – types, materials, properties – negative buoyancy; bobbins, tickler chain; Wire ropes – wires, strands, cores – selection of wire ropes, breaking strength, specification, Thimbles, shackles, rings, Otter board ,types-principle parts-G-links; Kelly's eye, stopper link , butterfly, Hooks; types, materials, specification numbering system, jigs, spoon hooks.

UNIT V

Design, construction and operation of various fishing gears; Selection of materials for different fishing gears ; Parts of a trawl net, purse seine, gill net and tuna long lines; Modern commercial fishing methods-Operation and classification of trawling, purse seining, lampara net fishing, gill netting, line fishing; light fishing, Squid jigging, electrical fishing- Selective fishing.

PRACTICAL

Handling of net braiding tools, making different knots, bends, hitches, net braiding using different knots- shaping, creasing, baiting, fly mesh tailoring – T-cuts, N-cuts, B-cuts. Calculations- joining of netting, lacing, seaming; Mounting methods, direct, indirect methods, related calculations-assembling of netting. mending of net, identification of synthetic and natural fibers twines, ropes, iron wares, fish hooks; Calculation of buoyancy, . pecification of ropes, wire ropes, rigging materials, methods. Seining, boat seines, beach seines, gill netting, drift set, trammel net fishing; Line fishing – pole and line, tuna long lines, squid jigging; Falling gear – cast nets; Lift nets, Chinese dip nets; Fishing experience in operation of traditional and modern fishing methods; Familiarization of various fishing accessories on board.

TEXT BOOKS

1. Baranov, F.I. ,1976. Selected Works on Fishing Gear. Vol. I. CommercialFishing Techniques. Israel Programme for Scientific Translations,Jerusalem.
2. Baranov, F.I., 1977. Selected Works on Fishing Gear. Keter press.
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.

BFSC 407. FISHERIES ECONOMICS (2+1)

THEORY

UNIT I

Economics: Definitions – Fisheries Economics – Major Divisions of Economics – Micro Economics and Macro Economics – Utility – Types – Law of Diminishing Marginal Utility – Demand, demand schedule, demand curve, law of demand, demand function – Elasticities of demand price,

Income and Cross – Types of elasticity of demand - Supply, supply schedule, supply curve, law of supply, supply function – Elasticity of supply – Types of elasticity of supply - Price – Market equilibrium price – Cob-web Theorem – Consumer's surplus – Indifference curves.

UNIT II

Production – Definition - Factors of production and their rewards – Production function – Production process – Factor-product relationship: Regions of production, TPP, APP and MPP curves and their relationships - Factor-factor relationship: Isoquant, Iso-cost line, Least Cost Combination, Types of substitution – Product-product relationship: Production Possibility curve, Iso-revenue line, Types of substitution, Production optimization - Cost and Income concepts – Break even analysis.

UNIT III

Farm planning and budgeting: Definition, Objectives, Importance and Types – Farm credit proposals - appraisal techniques – Record keeping – Farm financial management: Basic accounting procedures, double entry and single entry, financial statement analysis for solvency and Liquidity - Profit and Loss account – Income and Expenditure statement - Classification of assets and liabilities – Balance sheet - Profit maximisation – Risk and uncertainty.

UNIT IV

National Income - Definition – GDP, NDP, NNP, GNP. Contribution of fisheries to Indian economy - Employment – Introduction to GATT and WTO – IPRs – Patent – Design – Trade Marks – geographical indications – TRIPS – agreement on TRIPS - Non tariff barriers –Anti-dumping procedures – Sanitary, Phyto-sanitary and TBT measures – non-agriculture market access (NAMA) – bio-piracy and bio-prospecting.

UNIT V

Socio-economic aspects of fisherfolk: Importance and meaning – Definitions of gross and net disposable income and per capita income – Income distribution and Lorenz curve –

Consumption – Consumption function for a fisherman's family – Engel's law – microfinance and SHG : Definition– women empowerment – Gender Equity - Livelihood development.

PRACTICAL

Determination of market equilibrium for fish and fishery products, Estimation of price, income and cross elasticities, Determination of Break-even point for a Fisheries enterprise, Preparation of income statement, Preparation of Balance Sheet, Product curves, Production function analysis in capture fisheries, Production function analysis in culture fisheries, Preparation of enterprise budget.

Field visit:

Data collection on economic analysis of capture fisheries, Data collection on economic analysis of culture fisheries, Estimation of Consumption expenditure for a fisherman's family, Study on socio economic status of fisherfolk.

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. Addision Wesley.
6. Grafton, Q.R., J. Kirkley, T, Kompas and D.Squire, 2006. Economics for Fisheries Management. Ashgate Publ. Co.

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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 McGraw Hill.
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.

BFSC 408. DISASTER MANAGEMENT IN FISHERIES (1+0)

THEORY

UNIT I

Basic concepts - Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India.

UNIT II

Various disasters - 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 impact of various disasters.

UNIT III

Disaster Management strategies - 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.

UNIT IV

Response and recovery systems - 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.

UNIT V

Agencies in disaster management - 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.

REFERENCE BOOKS

1. Damon Coppola (2015) Introduction to International Disaster Management 3rd Edition, Publisher: Butterworth-Heinemann Paperback ISBN: 9780128014776.
2. Jane A. Bullock, George D. Haddow, Damon P. Coppola (2017) Introduction to Emergency Management 6th Ed. Publisher: Butterworth-Heinemann Paperback ISBN: ISBN-13: 978-0128030646
3. Harsh Gupta (2003) Disaster management, Universities Press (P) Ltd. ISBN: 8173714568
4. Alan Kirschenbaum (2003) Chaos Organization and Disaster Management, Marcell Dekker New York ISBN: 08247 47151
5. M. M SULPHEY (2016) Disaster management, Publisher: PHI Learning, ISBN: 9788120352209, 9788120352209
6. Jack Pinkowski (2008), Disaster Management Handbook, CRC Press ISBN 9781420058628

7. Brian Tomaszewski (2014)Geographic Information Systems (GIS) for Disaster Management 1st Edition, ISBN 9781482211689
8. Pardeep sahni, Alka dhameja, Uma medury (2010), Disaster mitigation: experiences and reflections, PHI learning (p) ltd.
9. Subramanian, R., 2018. Disaster Management, Vikas Publishing House, ISBN-10: 9352718704, ISBN-13: 978-9352718702
10. Mrinalini Pandey (2014) Disaster Management, Wiley (2014), ISBN-10: 8126549246
11. Tushar Bhattacharya (2017)Disaster Science and Management McGraw Hill Education; 1st edition (1 July 2017), ISBN-10: 9781259007361 and ISBN-13: 978-1259007361
12. Anil Kumar Gupta , Sreeja S. Nair, Sandhya Chatterji, (2013) Disaster Management and Risk Reduction: Role of Environmental Knowledge, Narosa Publishing House, ISBN-10: 8184872518ISBN-10: 8184872518, ISBN-13: 978-8184872514
13. FAO (2008),Disaster risk management systems analysis A guide book, ISBN 978-92-5-106056-8
14. Ministry of Home Affairs, GOI (2011) Disaster management in India

V SEMESTER

BFSC 501. COASTAL AQUACULTURE AND MARICULTURE (2+1)

THEORY

UNIT I

Global aquaculture production - Status of farming of selected species - Marine finfish, Crustaceans - Shrimps, spiny lobsters, Molluscs, Sea cucumbers, Sponges, Corals, Seaweeds. Resources for shore-based aquaculture and seafarming in india - Status of Coastal Aquaculture, Aquaculture Diversification Programmes, Major constraints, Diversification of Coastal Aquaculture. Seed resources of finfish and shellfish - Finfish

Seed Resources and Shellfish seed Resources. Traits of important cultivable species - Grey Mullets, Milkfish, Pearlspot, Asian seabass, Groupers, Snappers, Shrimps, Lobsters and Crabs.

UNIT II

Pond culture - Site Selection - Criteria to locate a good coastal farm site - Design and Construction of coastal ponds - Water Supply Systems - Cages - Pens - Culture methods for oyster, mussels and seaweeds. Water and soil quality management - Physical variables - Temperature , Salinity and Turbidity - Chemical variables -Dissolved oxygen, Total alkalinity, pH, Carbon dioxide, Ammonia, Nitrite and Nitrate and Hydrogen sulphide.

UNIT III

Culture of milkfish = Culture systems - Fry collection - Artificial propagation - Grow-out - Pond preparation., Water management - Supplementary feeding and Harvesting. Culture of grey mullets - Culture systems - Fry collection and Hatchery production - Grow-out operations. Culture of asian seabass - Source of seed -Grow-out culture. Culture of groupers - Biology and Seed supply - Culture techniques.

UNIT IV

Shrimp Culture - List of commercially important penaeid shrimps - Culture systems - Characteristics of shrimp culture systems - Considerations and Site selection - Grow-out operations - Pond preparation - Selection of shrimp fry (post larvae) - Stocking - Feeding - Water quality management and Aeration and Harvesting. Mud Crab Culture - Culture methods.

UNIT V

Oyster Culture - Culture techniques - Oyster culture in India. Mussel Farming - Grow-out - Seed collection and Growth and production. Culture of Pearl Oysters - Biology - Culture of Seaweeds - Main groups of algae cultivated for food - Culture systems.

PRACTICAL

Identification of characters of selected important cultivable species. Collection and identification of commercially important seed of fish and shellfishes. Identification of maturity stages. 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. Material, apparatus and machinery for shore-based aquaculture and sea farming. Design of shorebased aquaculture and seaf arming models.

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.

BFSC 502. MARINE FINFISH AND SHELLFISH BREEDING AND HATCHERY MANAGEMENT (2+1)

THEORY

UNIT I

Introduction to breeding of marine finfish and shellfishes - Marine finfish and shellfish seed resources - Commercially important marine crustaceans and molluscs -

their breeding possibilities - Hormonal control of marine crustacean reproduction - Reproductive physiology of marine crustaceans, molluscs and Echinoderms - Natural breeding process and seed availability. Life cycle of Penaeids, Crabs, Lobsters and craw fishes - Life cycle of marine bivalves and gastropods - Life cycle of Holothurians and Seahorses - Sexual maturity and breeding season of different marine finfish and shellfishes - Natural habitats for marine finfish and shellfish seed collection - Collection methods for different marine finfish and shellfish seeds - Identification characters of different marine finfish and shellfish seeds at various stages.

UNIT II

Qualities of different marine finfish and shellfish brooders, identification of sex and health parameters - Collection methods and selection procedure for marine finfish and shellfish brooders - Transportation process and procedure to be followed during the transport of brooders - Captive brood stock development, nutrition and water quality issues in the brooder maintenance - Identification of maturity stages in marine finfish and shellfishes - Maturation diet and importance of live feed in the brooder development - Seasonal factors influencing brooders - Quarantine of the brooders and disinfection processes.

UNIT III

Site selection for the construction of the marine finfish and shellfish hatcheries - Designs and construction of hatcheries for different marine crustaceans - Different tanks, their specifications and utility for the seeds production - Brood stock inducing methods for shrimps, prawns and crabs - Eyestalk ablation techniques and protocols - Different larval rearing techniques for shrimps, prawns, crabs and lobsters - Estimation of hatchability, larval biomass and counting the larvae - Post larvae settlement, collection, segregation and rearing - Designs and construction of marine hatcheries for different molluscs and holothurians - Brood stock maintenance and different inducing methods for molluscs and holothurians - Different larval rearing techniques - Estimation of hatchability, larval biomass and post larvae settlement and segregation.

UNIT IV

Water quality issues for different marine finfish and shellfish species, their management and maintenance - Feeds, selection of feed and feeding management for different marine finfish and shellfishes - Live feed culture, different species of live feeds, their nutritive value and utility in marine finfish and shellfish larval rearing - Health management and different disease conditions in seed production of different marine finfish and shellfishes - Disinfection protocol in hatcheries and water filtration and treatment processes.

UNIT V

Genetic aspects and selective breeding in marine crustaceans - Genetic improvement and hybridization in marine crustacean breeding - Feed biotechnology and development of novel feeds for larvae - Economic analysis of various marine finfish and shell fish seed production techniques,

PRACTICAL

Collection of information on different marine finfish and shellfish seed resources (Penaeids, Panulurids, Crabs, Molluscs and Holothurians) - Collection of different marine finfish and shellfish seeds from natural waters. Identification of different marine finfish and shellfish seeds - Identification of different larval stages of marine finfish and shellfishes - Visit to shrimp hatchery - Visit to bivalve hatchery - Construction of biofilter - Identification of different live feeds used in the marine shellfish hatchery - Preparation of larval feeds and feeding - Different marine shellfish hatchery models and layout preparations - Preparation of Spirulina based feed for brood stock and larvae - Packing of marine finfish and shellfish seeds and transportation - Visit to live feed production unit in CMFRI - Observation of different disease conditions in brood stock and larvae - Artemia nauplii production and feeding for larvae - Experiments on enrichment of Artemia.

TEXT BOOKS

1. Bardach, E.J., J.H. Rhyther and W.O. Mc Larney, 1972. Aquaculture. The Farming and Husbandry of Freshwater and Marine Organisms.John Wiley & Sons.
2. Gilbert, B., 1990. Aquaculture. Vol. I. Ellis Harwood.
3. Jhingran, V.G., 1991. Fish and Fisheries of India. Hindustan Publ.
1. Mcvey, J.P., 1983. Handbook of Mariculture. CRC Press.
2. Jhingran, V.G., 1991. Fish and Fisheries of India. Hindustan Publ. Corp.
3. Landau, M., 1992. Introduction to Aquaculture. John Wiley & Sons.

REFERENCE BOOKS

1. Mcvey, J.P., 1983. Handbook of Mariculture. CRC Press.
2. Jhingran ,V.G. and R.S.V. Pullin, 1985. Hatchery Manual for the Common,Chinese and Indian Major Carps. ICLARM, Philippines.
1. CMFRI Bulletin, 1987. National Seminar on Shellfish Resources and Farming.
2. Thomas, P.C., S.C. Rath and K.D.Mohapatra, 2003. Breeding and SeedProduction of Finfish and Shellfish. Daya Publ. House.

BFSC 503. FISH DISEASES AND MANAGEMENT (2+2)

THEORY

UNIT I

Significance of fish diseases in relation to aquaculture. Disease development process in fish and shellfish. Host, pathogen and environment interaction. Pathophysiology of fish diseases. Systematic pathology of fish and shellfish (I ntegumentary system, respiratory system, circulatory system, digestive system, excretory system, nervous system, musculoskeletal system, reproductive system, endocrine system).

UNIT II

Infectious diseases (Bacterial, viral and fungal diseases) of cultured finfish and shellfish. Pathogenicity and mechanism of bacterial, viral and fungal infections of finfish and shellfish. OIE listed and notifiable diseases. Principles of disease diagnosis. Case history and clinical signs in diagnosis. Conventional and rapid diagnostic techniques. Microscopical, microbiological, histopathological and biochemical methods. Antibody and nucleic acid based rapid diagnostics.

UNIT III

Parasitic diseases of fish and shellfish. Protozoan and metazoan parasites - Morphology, biology and life cycle of parasites. Important disease epizootics of wild fish population. Zoonotic diseases, non infectious diseases (nutritional, genetic, and environmental diseases).

UNIT IV

Defence mechanism in finfish and shellfish- specific and non specific immune system. Role of stress and host defence mechanism in disease development. Principles and methods of vaccine production and fish immunization. Fish vaccines & delivery mechanisms.

UNIT V

Health management in aquaculture. Preventive strategies. Quarantine and health certification in aquaculture. Crop rotation, Immunostimulants, bioremediation and polyculture as strategies for health management. Fish pharmacology – Pharmacokinetics and pharmacodynamics. Drugs, chemicals, antibiotics and probiotics used in aquaculture and their mode of action. Pharmacopeia. Therapeutics.

PRACTICAL

Methods of sampling fish and shellfish for disease diagnosis. Live and post mortem examination of diseased fish. Collection and identification of parasites. Morphological, biochemical and biological tests of bacteria, virus and fungi.

Immunological and molecular disease diagnostic techniques. Antibiotic sensitivity assays. Techniques in histology. Pathological changes in different organ systems associated with different pathogens. Methods of treatment.

TEXT BOOKS

1. Schaperclaus, W., 1986. Fish Diseases. Vols. I, II. Oxonian Press.
2. Andrews, C., A.Excell and N.Carrington, 1988. The Manual of Fish Health. Salamander Books.
3. Sindermann, C.J., 1990. Principal Diseases of Marine Fish and Shellfish. Vols. I, II. 2nd Ed. Academic Press.
4. Felix, S., K. Riji John, M.J.Prince Jeyaseelan and V.Sundararaj, 2001. Fish Disease Diagnosis and Health Management. Fisheries College and Research, Institute, T. N. Veterinary and Animal Sciences University. Thoothukkudi.
5. Humphrey, J., J.R.Arthur, R.P. Subasinghe and M.J. Phillips, 2005. Aquatic Animal Quarantine and Health Certification in Asia. FAO Publ.
6. Jorge, E., S.Helmut, W.Thomas and B.G. Kapoor, 2008. Fish Diseases. Science Publ.

REFERENCE BOOKS

1. Inglis, V., R.J. Roberts and N.R. Bromage, 1993. Bacterial Diseases of Fish. Blackwell.
2. Iwama, G. and T.Nakanishi (Eds.)., 1996. The Fish Immune System Organism, Pathogen and Environment. Academic Press.
3. Wedmeyer, G., F.P. Meyer and L. Smith ,1999. Environmental Stress and Fish Diseases. Narendra Publ. House.
4. Woo, P.T.K. and D.W. Bruno (Eds.). ,1999. Fish Diseases and Disorders. Vol. III. Viral, Bacterial and Fungal Infection. CABI.
5. Roberts, R.J., 2001. Fish Pathology. 3nd Ed. WB Saunders.
6. Shankar, K.M. and C.V. Mohan, 2002. Fish and Shellfish HealthManagement.UNESCO Publ.

7. Walker, P. and R.P. Subasinghe (Eds.)., 2005. DNA Based Molecular Diagnostic Techniques: Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases. FAO Publ.

BFSC 504. FISHERIES MARKETING AND FINANCE (2+1)

UNIT I

Market and marketing: Definition – Approaches to the study of marketing: product, functional, participant and decision making – Classification of markets: based on location, time, position of sellers, volume of business transactions and competition – Market structure: product market, factor market – Marketing functions: exchange, physical supply and facilitating.

UNIT II

Objectives and importance of fish marketing – Marketing channel: Definition – Types of marketing channel for fish and fishery products, Marketing efficiency – Price spread: Marketing costs, Marketing margins – Pricing policies: cost, competition and demand – Marketing environment: micro and macro –Product life cycle – Market segmentation - Marketing Mix – Advertising and sales promotion – Consumer behavior – Marketing research.

UNIT III

Role of functions of marketing intermediaries: merchant middlemen and agent middlemen – Price determination in fish markets – Marketing infrastructure – Problems in fish marketing – Strategies for fish market development.

UNIT IV

Export markets: meaning and definition – Export and import procedures – Pattern and performance of fishery product

export from India – Trade liberalisation and fisheries exports – Role of MPEDA in fish and fishery product export development.

UNIT V

Fisheries credit – Classification and types based on repayment period – 3 R's of credit – Credit requirements of fisherman – Sources of credit / finance: indigenous and institutional – Sources of institutional finance; commercial banks, regional rural banks, financial institutions of state and central.

PRACTICAL

Developing questionnaire and conducting market surveys, Exercises on equilibrium price for fish and fishery products: Identification of marketing channels and its efficiency. Visit to fish markets. Developing advertisement for fishery product. Analysis of seafood export data. Visit to export development organization, commercial banks and regional rural banks.

TEXT BOOKS

1. Amarchand, D. and B.Varadharajan, 1979. An Introduction to Marketing. Vikas Publ.
2. Chaston I., 1983. Marketing in Fisheries and Aquaculture. Fishing News Books.
3. Ian C., 1984. Marketing In Fisheries and Aquaculture. Fishing News Books.
4. Adcock, D., R.Bradfield, A.Halborg and C.Ross, 1995. Marketing Principles and Practice. Pitman Publ.
5. Dennis, A., R. Brandfield, Al Halhorg and C. Ross, 2004. Marketing Principles and Practice. Pitman Publ.

REFERENCE BOOKS

1. Jolson, M.A., 2004. Marketing Management. Macmillan Publ.
2. Kotler, P., 2005. Marketing Management. Prentice Hall of India.
3. Kotler, P. and G.M. Armstrong, 2006. Marketing: An Introduction. Prentice Hall.

4. Phillip, K. and G. Armstrong, 2007. Principles of Marketing. Prentice Hall.
5. Phillip, K., 2008. Marketing Management. 12th Ed. Prentice Hall of India

BFSC 505. FISHING CRAFT TECHNOLOGY (1+1)

THEORY

UNIT I

Introduction: History & development of fishing crafts Classification of fishing crafts based on fabrication, dimension, nature of fishing, depth of operation etc. Traditional fishing crafts of India- History & development of mechanization of fishing crafts.

UNIT II

Boat building materials- their preparation, seasoning, preservation & their advantages & disadvantages; Choice of construction material; comparison of mechanical properties; relative advantages and disadvantages.

Basic mathematics & Hydrostatics for designing of fishing vessels -Form co-efficient & proportionality ratios; Calculation of displacement, water plane area. Simpson's rules-Design procedure: Displacement- weight equation; estimation of light weight ship.

UNIT III

Important terminologies of fishing vessel & related to fabrication; Drawing conventions in naval architecture; Deck layout – trawlers purse seiners, long liners, gill netters and combination fishing.

Boat construction methods

Construction of wooden boats steel boats, fiber glass boat, aluminum and Ferro-cement boat; Boat maintenance and common fouling and boring organisms.

Stability of fishing vessel

Longitudinal, transverse; various equilibrium of ships – stable, unstable and neutral; Resistance of boats.

UNIT IV

Introduction to Marine Engines – Fundamentals of heat – Thermodynamic laws – Basics of Engines – Heat Engines - Classification of engines – IC engines –Types and parts – Petrol – Diesel – Two stroke – four stroke engines – parts of an engines – comparison of these engines- Fuel system, lubricating system- cooling systems – starling system – super charging and turbo systems – out board engines – working and types; Measurement of engine power IHP, BHP, THP and Efficiency ratings of engines Care and Maintenance of engines.

UNIT V

Stern gear assembly, Propellers basics- types – powering of propellers – efficiency – thrust – propulsive co-efficient – power margin – power rating; Propellers – Types & working, Fixed pitch and variable pitch propellers-Rudder-types, functions.

PRACTICAL

Study on Traditional crafts & various boat building materials. Introduction to engineering drawing: Lettering & dimensions; Projection & its styles. Simple projection & complex projection of an object; Drawing of traditional crafts: catamaran & Satpati, etc; Drawing of backbone assembly & U & V bottom hull of boat. Lines plan drawing of small fishing vessel: body plan, profile & half breadth plan; Drawing of deck lay outs of various fishing crafts: trawlers, gill netters, long liners, squid jiggers etc; Designing of fishing vessel from a parent vessel; Study of propeller & stern gear assembly. Study on marine fouler & borers; Visiting harbors, boat building yards & dry docking yard; Basic calculations on marine engineering – Diesel and Petrol engines; Two stroke and four stroke engines – IC engine – Parts of IC engines – various system of marine engines – study of starting system – fuel system – cooling system – lubrication system – propellers-Rudder assembly.

TEXT BOOKS

1. Fyson, J.F. (Ed). ,1985. Design of Small Fishing Vessels. Fishing NewsBooks.
2. Pike, D. ,1988. Fishing Boats and Their Equipments. Fishing News Books
3. Marine Institute, 1988. Proc. World Symposium on Fishing Gear andFishing Vessel Design, The Newfoundland and Labrador Institute of Fisheries and Marine Technology, St. John's, Newfoundland,Canada.
4. Sanisbury, J.C., 1996. Commercial Fishing Methods-An Introduction toVessels and Gear. Fishing News Books.

REFERENCE BOOKS

1. Traung, T. ,1967. Fishing Boats of the World. Fishing News Books.
2. Shenoy, L., 1988. Course Manual in Fishing Technology. CIFE, Mumbai.
3. Sreekrishna ,Y. and L.Shenoy, 2001. Fishing Gear and Craft Technology.ICAR.
4. Yadav, Y.S., 2002. Traditional Fishing Craft of the Bay of Bengal. BOBP,Chennai.
5. Ponnambalam ,A. ,2003. Fishing Craft Technology. CIFNET, Cochin.

BFSC 506. NAVIGATION AND SEAMANSHIP (1+1)

THEORY

UNIT I

Introduction to Navigation and Seamanship

Introduction to Navigation – Types of Navigation – Definitions of Coastal Navigation – Dead Reckoning - Celestial Navigation- Radio Navigation- Satellite / Electronic Navigation. Earth & its co-ordinates- Definition & importance of Equator, latitude, longitude, Great circle, small circle, Rhumb line. Distance & Direction in navigation. Rhumb line – Rules of the

Road – Rule No. 3 – General definitions, Rule No. 21, Lights Definition – Mast head light, side light, stern light, all rounds light, towing light, Rule No. 26, Rules for fishing vessels.

Navigational Charts

Map Vs chart – importance of charts – types of charts - Definitions of world chart, Ocean chart, coastal charts & Plan charts– chart projection – chart description – chart symbols and abbreviations – chart reading.

UNIT II

Navigational Aids

Magnetic compass – working principle – types of compass – parts of magnetic compass – construction - compass error – variation and deviation – Dry card and wet card compass. Gyro compass – working principle – parts advantage and disadvantages **Marine Sextant -** Working principle – parts of sextant - Adjustable and Non adjustable errors – Measurement of Angles by using marine sextant. Pelorus & Azimuth mirror.

UNIT III

Sounding Equipments & speed logs

Lead line: Types – construction and Markings of lead line – operation.

Echo sounder: Working principle – Block diagram –Transducer – Transmitter – Receiver – Recorder / display unit – working of echo sounder – special features such as white line technique & Time Varied Gain (TVG) – Uses of Echo sounder in Fisheries. **SONAR:** working principle – Block diagram – parts of SONAR – Uses of SONAR in Fisheries.

Net Sonde / Trawl eye: working principle – parts of Net sonde – uses in trawl net preparation.

Speed logs: PRM meter – patent log – ship / chip log – Doppler log –Pilot tube / hydrostatic log – Electromagnetic log –

impeller log – working principle – Advantages and disadvantages.

GPS: Global Positioning system – working principles –segments of GPS – Space segment, Ground controlling and monitoring segments & Receiving system- Operation and features of GPS – Advantages of GPS – Uses of GPS in Fisheries.

Direction Finder: working principle – parts – Advantages and Disadvantages.

UNIT IV

Signals & Communication - Navigational signals - Importance of signals – Types of signals – flag , sound, light, Distress signals – Day and Night signals for fishing vessels – Procedure for sending distress signals by Radio Telephony.

Marine buoyage system: Lateral Marks, cardinal marks, safe water marks, Isolated danger marks, New danger marks, VHF Marine communication system –working principle – importance – utility for fishing vessels.

RADAR: Working principle – Block diagram-parts – functioning – uses.

Unit V: Sea safety and Seamanship

Fire Fighting – Fire triangle – Types of Fire – Types of Fire extinguishers.

Life saving appliances – Life jacket, Life buoy- buoyant apparatus – EPIRB & SART, Pyrotechniques.

Manning regulation in Fishing vessels Anchors - Types & Anchoring, Mooring - Definition and methods Man over Board procedures – Methods Action during stranding Bad weather preparation & weather warning signals.

PRACTICAL

Chart reading – position fixing –chart symbols – Changing from true course to compass and from compass course to true course with or without wind; finding the course

to steer time required from and to given positions; Finding position reached after steering a given course and speed. To find the position of the vessel by the different methods and to find compass error and deviation by transit bearing of two shore objects. Magnetic compass – sextant; To study different types of knots and bends and their use at the sea; Operation of echo sounder, V.H.F. SONAR, Radar, Global Positioning System. Signals, Navigational lights – Flag signals, life saving appliances.

TEXT BOOKS

1. William Hall, 2012. Navigation. Dodge Publishing Company.
2. Abdul Khalique and Nadeem Anwar, 2006. Passage planning practice. Witherby Pulisher.
3. Anwar Nadeem, 2015. Navigation advanced-Mates and masters. Witherby Publisher. 2nd edition.

BFSC 507. FISH POPULATION DYNAMICS AND STOCK ASSESSMENT (2+1)

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.

UNIT II

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

UNIT III

Estimation of total, fishing and natural mortality.Monte Carlo simulation model and ECO PATH model.

UNIT IV

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

UNIT V

Biological symptoms of under fishing and over fishing. Growth over fishing and recruitment over fishing.Eumetric fishing. Open access fisheries. Fisheries regulations.CPUE. Trawl selection and gillnet selection.

PRACTICAL

Segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

TEXT BOOKS

1. Ricker, W.E., 1971. Methods for the Assessment of Fish Production inFreshwaters. Blackwell, Oxford & IBH.
2. Gulland, J.A. (Ed.)., 1977. Fish Population Dynamics. John Wiley & Sons.
3. Nickolskhi, G.V., 1980. Theory of Fish Population Dynamics as theBiological Background for Rational Exploitation and Managementof Fishery Resources. Bishen Singh Mahendra Pal Singh, DehraDun.
4. Beverton, R.J.H. and S.J. Holt, 2004. On the Dynamics of Exploited Fish Population. The Blackburn Press.

REFERENCE BOOKS

1. Edwards, E.F. and B.A.Megrey, 1989. Mathematical Analysis of Fish StockDynamics. American Fisheries Society, Maryland.
2. Ray, H. and J.W. Carl, 1992. Quantitative Fisheries Stock Assessment Choice,Dynamics and Uncertainty. Kulwer.
3. Gulland ,J.A., 1992. A Review of Length Based Approaches to AssessingFish Stocks. FAO Tech. Paper No. 323, Rome.
4. Callucci, V.G., S.B. Saila, D.J. Gustafson and B.J.Rothschild, 1996. StockAssessment, Quantitative Methods and Applications for Small Scale Fisheries. Lewis Publ.

5. Sparre, P. and S.C.Venema ,1998. Introduction to Tropical Fish StockAssessment. Part 1 Manual. FAO. Fisheries Tech. Paper No. 301,Rome.

BFSC 508. FISHERIES ADMINISTRATION AND LEGISLATION (2+0)

THEORY

UNIT I

Introduction to public administration – Definition – Principles and scope of Administration Public Enterprises – Importance and characteristics units of organisation and organisation chart.

UNIT II

Fisheries Division – Organisation chart – Centrally sponsored fisheries schemes – Ministries dealing Fisheries activities – State Fisheries Department : organisation chart and Implementation details of fisheries schemes – BFDA and FFDA activities.

UNIT III

National Fisheries Development Board- ICAR Institutes – Board – Institutes of Fisheries Division, Government of India – Coastal Aquaculture Authors – State Fisheries Corporation – Cooperative federation and societies.

UNIT IV

Fisheries resources and utilisation – Need for Fisheries legislation – Fisheries legislations - Indian Fisheries Act 1897 – Marine Fishing Regulation Act.

UNIT V

Environment protection Act, 1986 – Wildlife (protection) Act, 1872 and amendments – Biological Diversity Act, 2002 – Coastal Regulation Zone Notification, 1991-

Community Based Fisheries resource management – Code of conduct for responsible fisheries UN International law of the seas (1982) – Inter national commissions on Fisheries.

REFERENCE BOOKS

1. Csirke, J. 1984. Report of the Working Group on Fisheries Management Implications and Interactions. FAO Fish. Rep., 291, 67-90.
2. Devaraj, M. and E. Vivekanandan. 1999. Marine fisheries of India: challenges and opportunities. Curr. Sci., 76, 315-332.
3. Gulland, J.A. 1972. Some notes on the demersal resources of southeast Asia. Indo-Pacific Fish. Counc., 13, 51-60.
4. Ramchandran, C. 2004. Teaching Not To F(in)ish!? : A Constructivist Perspective on Reinventing a Responsible Marine Fisheries Extension System.
5. Silvestre, G. and D. Pauly. 1997. Management of tropical coastal fisheries in Asia: an overview of key challenges and opportunities. In: Status and Management of Tropical Coastal Fisheries in Asia (G. Silvestre and D. Pauly, eds.). ICLARM Conf. Proc., 53, 8-25.
6. Vivekanandan, E. 2004. Fisheries management techniques In Technical notes for the winter school on Ecosystem based management of marine fisheries held at CMFRI, 2004 (Mohammed,K.S. ed.): 98-109.
7. Sudarsan, D; M.E. John and Somavanshi. V.S. 1990. Marine fishery resources potential in the Indian exclusive economic zone - an update. Fishery Survey of India, Mumbai.

VI SEMESTER

BFSC 601. FISH QUALITY ASSURANCE (1+1)

THEORY

UNIT I

Introduction – Quality – Quality Control - Quality Assurance – Intrinsic quality in raw fish – Factors affecting intrinsic quality - Extrinsic quality in raw fish – Microbiological deteriorations – Enzymatic deteriorations – Non-enzymatic deteriorations

UNIT II

Spoilages and quality indices in chilled fish – microbial, enzymatic, non-enzymatic; Spoilages and quality indices in frozen fish – microbial, enzymatic, non-enzymatic; Spoilages and quality indices in canned and retort pouch processed fish – microbial, enzymatic, non-enzymatic; Spoilages and quality indices in cured fish (salted, dried and smoked) – microbial, enzymatic, non-enzymatic; Spoilages and quality indices in fermented fish and value added fish products – microbial, enzymatic, non-enzymatic..

UNIT III

Assessment of quality of fish and fishery products – sensory/ subjective, objective – physical - instrumental, chemical/ biochemical, microbiological, statistical methods

UNIT IV

Concept of Quality Management; TQM, GMP; HACCP; FSMS; Quality standards – National -BIS- EIC – FSSAI; International – ISO, USFDA, EU and Codex.

UNIT V

Process water quality; Fish plant sanitation- SSOP- SCP- GHP- Disinfectants, detergents and cleaning schedule. CIP; Waste management in fish processing industries.

PRACTICAL

Assessment of sanitation in fish processing plants, Indices of freshness and quality of fresh and processed fish. Sensory evaluation, hedonic scale, physical and chemical methods of assessment of quality of fish and fishery products. Determination of available chlorine. Visit to factory & Study of Hazard analysis Critical Control Point (HACCP) system and its implementation.

TEXT BOOKS

1. Kreuzer, R., 1971. Fish Inspection and Quality Control. Fishing News.
2. Anthony, T.T., 1988. Handbook of Natural Toxins. Marine Toxins and Venom. Vol. III. Marcel Dekker.
3. Connell, J.J., 1995. Control of Fish Quality. Fishing News Books.
4. Balachandran, K.K., 2001. Post Harvest Technology of Fish and Fish Products. Daya Publ. House.

REFERENCE BOOKS

1. Kreuzer, R., 1971. Fish Inspection and Quality Control. Fishing News Books.
2. Fennema, K., W.D. Powrie and E.H. Marth, 1973. Low Temperature Preservation of Foods and Living Matter. Marcel Dekker.
3. John DEV, 1985. Food Safety and Toxicity. CRC Press.
4. Huss, H.H., M. Jakobsen and J.Liston, 1991. Quality Assurance in the Fish Industry. Elsevier.
5. Hall, G.M. (Ed)., 1992. Fish Processing Technology. Blackie.
6. Gorbutt, J., 1997. Essentials of Food Microbiology. Arnold Hodder Headline Group.
7. Hui, Y.H., D.P. Merle and G.J. Richard (Eds.)., 2001. Food Borne Disease Handbook. Seafood and Environmental Toxins. Vol. IV. Marcel Dekker.
8. Gopakumar K. (Ed.)., 2002. Text Book of Fish Processing Technology.ICAR.
9. Kanduri, L. and R.A. Eckhartt, 2002. Food Safety in Shrimp Processing. Fishing News Books.

10. Huss, H.H., 2003. Assessment and Management of Seafood Safety and Quality. FAO Tech. Paper No. 444.
11. Vincent, K. and J.E.R. Omachonu, 2004. Principles of Total Quality. CRC Press.
12. Sen, D.P., 2005. Advances in Fish Processing Technology. Allied Publ.
13. Shukla, R.K., 2006. Total Quality Management Practicing Manager. New Royal Book.

BFSC 602. FISH FREEZING TECHNOLOGY (2+ 1)

THEORY

UNIT I

Introduction to freezing technology, characteristics of fish and shell fishes: structure and function of fish muscle- lipids, proteins, n – containing extractives, vitamins and minerals - changes in fish after death -*changes in raw fresh fish* - *changes in eating quality* - autolytic changes - *autolysis and nucleotide catabolism* - spoilage of fish, spoilage and pathogenic microorganism - native bacterial flora of fishes - factors that influence the growth of microorganisms.

UNIT II

Handling fresh fish; sanitation in processing plants; principles of low temperature preservation - chilling of fish – methods and equipment for chilling; icing – quality of ice, ice-making; block ice - flake ice - plate ice - tube ice - slurry ice in fish preservation - super chilling - *advantages of chilling of fish with ice* - chilled *storage* - storage method - bulking - shelving - boxing - refrigerated or chilled sea water; chilling rate; calculation of the ice requirement for cooling - heat requirements - calculation of the ice requirement for the storage of fish - spoilage of fish during chilled storage; use of antibiotics and chemicals - use of chlorine in fish processing - factor influencing sterilization of water by chlorine.

UNIT III

Freezing of fish – fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing; types of freezer - cryogenic, immersion freezing, calculation of freezer refrigeration load - freezing time - calculation of freezing times - physio-chemical changes that occurs during freezing – mechanism of ice-crystal formation; preparation of fish for freezing - freezing of fish freezing of prawns (shrimps) - .freezing of lobsters, freezing of crab - freezing of cuttlefish and squid - product name - frozen cuttle fish - freezing process of tuna.

UNIT IV

Coding, packing and storage - changes that occur during frozen storage – microbiological, physical and chemical changes; protein denaturation, fat oxidation, dehydration, drip.

UNIT V

protective treatments – polyphophate, glazing, antioxidants, packaging; thawing of frozen fish – method of thawing - thawing in air - water thawing - thawing between heated plates – HACCP.

PRACTICAL

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 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.

BFSC 603. FISHERIES BIOTECHNOLOGY AND BIOINFORMATICS (1+1)

THEORY

UNIT I

Fields of Biotechnology - Historical events related to biotechnology - - Nucleic Acids - Structure, Chemistry & Genetic Code - DNA as genetic material - Evidence that genes are made of DNA (or sometimes RNA) - The chemical nature of Nucleotides - DNA Structure - The Genes made of RNA - Variety of DNA structures - Properties of DNA - Classification of genes - Activities of genes - Mitochondrial DNA - Genetic code - Organization of genome in prokaryotes and eukaryotes - Gene structure - Gene expression in prokaryotes - Bacterial operons - Gene Expression in Eukaryotes - DNA replication - Origins of a replication - The replication fork - Leading strand

and Lagging strand - Dynamics at the replication fork - Termination of replication - Types of replication - Meselson-Stahl experiment - Transcription - Initiation - Elongation Resource - Termination - Processing the mRNA Transcript Resource - Translation.

UNIT II

Genetic Engineering - Recombinant DNA Technology - Enzymes commonly used in recombinant DNA technology - DNA polymerase and reverse transcriptase - Vectors - Shuttle vectors and Bacteriophages - Cosmids - Yeast cloning vectors - Shuttle vectors - Cloning a Gene - Cloning foreign DNA into the circular DNA of a plasmid -Cloning in Eukaryotes Preparation of a DNA Library - Colony hybridization - Probes -Screening - cDNA cloning - Construct ion and screening of a complete expression of cDNA library - Transgenic fish production - Advantages of fish as transgenics -Selection of species Genes - Growth hormone gene - Antifreeze protein genes -Disease resistance - Reporter genes - Methods of gene transfer - Microinjection - Electroporation - Detection of transgenes - Southern blot hybridization - Northern blot - Western blotting - Food safety of transgenic (GM) fish - Environmental impact of transgenic fish.

UNIT III

Cell culture and Cell lines - Adherent cultures Resource - Suspension cultures - Types of cell culture - Primary cell culture - Continuous cell cultures - Commonly used media for fish cell culture - Requirements of cell culture - Preparation of fish for explants - Storage - Long-term storage - Application of fish cell cultures - Isolation and identification of fish viruses - Marine invertebrate tissue culture. Hybridoma Technology - Production of monoclonal antibodies - Application of Monoclonal Antibodies in Fish Farming - Specificity and commercial availability of monoclonal antibodies for use in aquaculture . Molecular Techniques - PCR: Principles and applications in Fisheries - Different versions of PCR - Applications of PCR - - Molecular and Immunological

Techniques applied in fisheries - Electrophoresis - DNA Fingerprinting - Nucleus transplantation - Cloning - DNA – based diagnostics - Advantages of molecular methods - Disadvantages - Immunological techniques - Dot immunobinding assay - Western blotting -Latex agglutination test.

UNIT IV

Development of Vaccines - Mode of preparation of fish vaccines - Methods of vaccine inactivation - Killed whole cell vaccines - Live–attenuated vaccines - Recombinant DNA-based vaccines - Recombinant protein vaccines - Peptide vaccines - Genetically modified live vaccines - Genetic vaccines or Nucleic acid vaccines - DNA vaccines - - RNA vaccines - Subunit vaccines - Vaccine delivery system - Environmental, ethical and regulatory aspects of fish immunization. Marine biotechnology - Bioactive compounds from marine organisms - Marine bacteria - Marine fungi - Marine microalgae -Marine macroalgae - Marine sponges - Sea Anemones - Ascidians - Tunicates - Sea Hares - Marine Toxins. Environmental Biotechnology - Treatment of aquaculture wastewater - Nitrogen removal - Nitrification - Denitrification - Heterotrophic denitrification - Autotrophic denitrification - Phosphate removal - Bioremediation in aquaculture systems - Bioremediation of organic detritus - Bioremediation of Nitrogenous compounds - Bioremediation of Hydrogen Sulphide - Bioremediators as disease controlling agents.

UNIT V

Biofilters in aquaculture - Characteristics of real biofilters - Aquatic plant systems - Fluidized bed sand filters - Bead filters - Biodisks or RBC (Rotating Biological contractors) - Trickling filters - Submerged bed filters - Submerged filters. Biofertilizers - Potentials of Azolla - Application of Azolla in aquatic system - Cultivation of Azolla - Applications in fish farming – Probiotics - The use of probiotics in aquaculture - Probiotic preparation - Bacillus spp. - *Saccharomyces cerevisiae* - Safety and evaluation of probiotics - Prebiotics. Biosensor - Advantages (bioavailability, etc) and concept -

Prokaryotic biosensors - Eukaryotic biosensors - Components of a biosensor - Applications - Biosensors in food analysis - Biosensors in aquatic environment assays - Aequorin - Biosensors in the detection of fish toxins - Bio-processing - Enzyme Engineering - Whole – cell Bioreactors - Transport and adhesion of cells - Bioseparation . Bioinformatics - Overview and Applications - Databases and analytical tools - Classification of biological databases - Specialized databases - Tools for sequence analysis - Phylogenetic Analysis - Genome annotation tools - Proteomics tools - In-silico drug designing .

PRACTICAL

Isolation and quantification of DNA. Electrophoresis. ELISA, Immunodots, PCR, Western blot, immunofluorescence, immunoperoxidase, DNA hybridisation, Setting of biofilters, Bioprocessing of organic wastes. Practicals on genebank sequence database.

TEXT BOOKS

1. Primrose, S.B., 1989. Modern Biotechnology. Blackwell.
2. Fingerman M, R. Nagabhushanam and M.F. Thompson, 1997. Recent Advances in Marine Biotechnology. Vols. I-III. Oxford & IBH.
3. Glick, B.R. and J.J. Pasternak, 1999. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. ASM Press.
4. Nagabhushanam, R, A,D, Diwan, B.J. Zahurnec and R. Sarojini, 2004. Biotechnology of Aquatic Animals. Science Publ.
5. Pandian, T.J., C.A. Strüssmann and M.P.Marian, 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ.
6. Reddy, P.V.G.K., S. Ayyappan, D.M. Thampy and Gopalakrishna, 2005. Text Book of Fish Genetics and Biotechnology. ICAR.
7. Felix, S., 2007. Molecular Diagnostic Biotechnology in Aquaculture. Daya Publ. House.
8. Ramesh, R.C. (Ed.)., 2007. Microbial Biotechnology in Agriculture and Aquaculture. Vol. II. Science Publ.

9. Nair, P.R., 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.

REFERENCE BOOKS

1. Attwood, T.K. and D.J.P., Smith, 1999. Introduction to Bioinformatics. Addison Wesley Longman.
2. Brown, S.M., 2000. Bioinformatics: A Biologist's Guide to Biocomputing and the Internet. Eaton Publ.
3. Mount, D.W., 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Press.
4. Baxevanis, A.D. and B.F. Ouellettee, 2002**.** Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins. John Wiley & Sons.
5. Rashidi, H.H. and L.K. Buehler, 2005. Bioinformatics Basics: Applications in Biological Sciences and Medicine. CRC Press.
6. Singh, B., 2006. Marine Biotechnology and Aquculture Development. Daya Publ. House.
7. Zhanjiang, J.L., 2007. Aquaculture Genome Technologies. Blackwell.
8. Campbell, M.A. and L.J. Heyer, 2003. Discovering Genomics, Proteomics, and Bioinformatics**.** Benjamin Cummings.
9. Lesk , A.M., 2008**.** Introduction to Bioinformatics. Oxford University Press.

BFSC 604. REFRIGERATION AND EQUIPMENT ENGINEERING (2+1)

THEORY

UNIT I

Introduction to Refrigeration and Equipment Engineering - Laws of thermodynamics, Heat – Heat transfer – thermo dynamic systems – system properties – Methods of producing low temperature, sensible heat, latent heat, pressure, volume and temperature; thermodynamic cycles; enthalpy; entropy. Refrigeration – principles. General layout and

construction of Fish processing plants – freezing plant canneries, cold stores – Anteroom, Air lock. Ice Manufacturing Units – Block, Flake, tube and plate, ice.

UNIT II

Vapour Compression and vapour Absorption Refrigeration Systems.

Vapour Compression system – working principle – parts of system – compressor, Condenser, Receiver, Expansion device and Evaporator – working of the system. **Vapour Absorption system –** working principle – parts of the system – Advantages and Disadvantages.

Types of Compressors – Types of Condensers – Types of Expansions devices, Types of evaporators – oil accumulators and Driers.

UNIT III

Defrosting, Refrigerants and heat load

Methods of defrosting – Refrigerant charging.

Refrigerants –Types of refrigerants – Primary and Secondary ref rigerants – Ammonia, Freon group, ref rigerants – properties – advantages and disadvantage- Brine solution – Dry ice – Co2 gas, Cryogenic freezing medium – Liquid Nitrogen.

Refrigeration – effect, efficiency, COP, Ton of Refrigeration, Heat load calculation.

Insulation Materials – Types – Properties – Advantages and disadvantages – Cork, Thermocole, PUF, Glass wool etc.

UNIT IV

Processing Machineries

Equipment used in fish processing plants, washer, Deskinner, Deheader, Guttting machine, grader, slicer, de-boner etc. – Freezers – types – air blast, plate, cryogenic freezers. Canning Machineries, Packaging machineries, Freeze-drying principle - Equipment working. Irradiation – Principle Equipments. Cryogenics – principle equipments. General

Maintenance and safety aspects of fish processing equipment and Processing plants.

UNIT V

Fishing Vessel Machineries

Fishing Vessel general layouts - Power transmission system in fishing vessels – Gears, belt and chain systems.

Winches – Types and Working.

Deck Fittings and Fishing accessories – Net haulers, Line haulers, gurdy, power blocks, Fish pumps, Bilge pumping system.

Drives – Mechanical, Hydraulic, Pneumatic and Electrical Systems.

PRACTICAL

Graphically represented symbols used in refrigeration; Calculation on thermodynamics; temperature scale conversion; handling and operation of refrigerants, compressors, condensers, evaporators and expansion valves; defrosting in refrigeration system; Calculations on refrigeration effect and cooling estimate; Calculation on heat load, wall heat gain load and air change load; Studies on power transmission; Refrigeration machinery maintenance and safety precaution. Ice making and harvesting; Ice requirement calculation; Visit to a processing plant refrigeration unit; Conventional representation of common engineering component and features; Operation and maintenance of ice making machinery, canning machinery, fish products machinery and packing machinery. Study on different types of gallows. Visit to a fish products machinery and packing machinery; Study on different types of gallows. Visit to a fish processing unit to study the equipment used in different types of processing.

TEXT BOOKS

1. Sternin, U.G., I.V. Nikonorou and B.K.Yu, 1976. Electrical Fishing. Keter Publ.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.

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.
9. Shawyer, M. and A.F.M. Pizzali, 2003. The Use of Ice on Small Fishing Vessels. FAO Tech. Paper No. 436. Rome.
5. Venugopal, V. , 2006. Seafood Processing. Taylor & Francis.

BFSC 605. INTRODUCTION TO FISH BUSINESS MANAGEMENT (1+1)

THEORY

UNIT I

Business – Meaning and characteristics – objective of business – requisites of a successful business ; economic and social – scope of business – types of industries – relationship between industry, commerce and trade.

UNIT II

Management – Meaning and Characteristics – difference between Management and Administration – Scope of management – Functions of Management: planning, organizing, staffing, directing and controlling – management process – Decision making: Definition, Importance, Process, Decision tree.

UNIT III

Management by objectives – definition, principles, strength and disadvantages – SWOT Analysis – Investment analysis – Ratio analysis – PERT and CPM Techniques.

UNIT IV

Fisheries project – Definition – Project cycle – 5 stages – Project preparation criteria – Project appraisal and evaluation – undiscounted criteria – SRR and Pay back period – Discounted Criteria – NPV, BCR and IRR.

UNIT V

Fish business – Definition and objectives – Types of small business – Forms of business organizations – steps for starting a small scale business – business location, incentives, subsidies, sickness and insurance – business ethics.

PRACTICAL

Identification of fish business- Guidelines to start a small business- ratio analysis – project appraisal by discounted criteria - project appraisal by undiscounted criteria – Break –

even analysis of a small business-visit to successful fish business units- SWOT analysis of a business enterprise.

TEXT BOOKS

1. Amarchand, D. and B.Varadharajan, 1979. An Introduction to Marketing. Vikas Publ.
2. Chaston I., 1983. Marketing in Fisheries and Aquaculture. Fishing News Books.
3. Ian C., 1984. Marketing In Fisheries and Aquaculture. Fishing News Books.
4. Adcock, D., R.Bradfield, A.Halborg and C.Ross, 1995. Marketing Principles and Practice. Pitman Publ.
5. Dennis, A., R. Brandfield, Al Halhorg and C. Ross, 2004. Marketing Principles and Practice. Pitman Publ.

REFERENCE BOOKS

1. Jolson, M.A., 2004. Marketing Management. Macmillan Publ.
2. Kotler, P., 2005. Marketing Management. Prentice Hall of India.
3. Kotler, P. and G.M. Armstrong, 2006. Marketing: An Introduction. Prentice Hall.
4. Phillip, K. and G. Armstrong, 2007. Principles of Marketing. Prentice Hall.
5. Phillip, K., 2008. Marketing Management. 12th Ed. Prentice Hall of India

BFSC 606. TOXICOLOGY (1+1)

THEORY

UNIT I

General toxicology. Toxicity and metabolism: Factors influencing toxicity-environmental, genetic and nutritional; Measurement and evaluation of the ecological effects of toxicants; Metabolism of toxic substances by aquatic organisms - consequences, synergistic and antagonistic effects; Acute poisons and accumulative poisons; Bioaccumulation and

biomagnification; Systemic effects of toxic metals, pesticides and herbicides; Effect of select toxicants on aquatic life and detoxification. Toxicity of drugs.

UNIT II

Toxicity evaluation: Toxicity Testing - Microcosm and Mesocosm Tests, Dose-Response Relationships, Toxicity Bioassay. Sources of pollutants /toxicants in aquaculture.

Unit III

Genotoxicity; adaptation and inheritance. Mutagens and teratogens.

PRACTICAL

Toxicity evaluation of heavy metals on selected organisms by bioassay techniques; Estimation of LD50 and ED50. Demonstration of drug toxicity. Toxicity assessment of pesticides, PCBs and oil on selected organisms; Analysis of heavy metals from aquatic ecosystems; Toxicity testing methods.

REFERENCE BOOKS

1. Michael J. Derelanko and Mannfred A. Hollinger, 2002. Handbook of Toxicology, Second Edition CRC Press: Boca Raton.
2. Nikinmaa, M., 2014. An Introduction to Aquatic Toxicology. 1st Edition, Kindle Edition.
3. Walker, C.H., 2006. Principles of Eco-Toxicology - Third Edition. CRC Press Taylor & Franchis Group, Boca FL.
4. Gary M. Rand, 1995. Fundamentals of Aquatic Toxicology: Effects, Environmental Fate And Risk CRC Press.
5. David J. Hoffman, Barnett A. Rattner, G. Allen Burton and John Cairns, 2004. Handbook of Eco Toxicology, Lewis Publishers.
6. Giesy, J.P. and P.M. Alred,1985 Replicability of aquatic multi species test system in multi species toxicity testing, Pergamon Press New York.

BFSC 607. CHEMOTHERAPY AND DRUGS IN AQUACULTURE (1+1)

THEORY

UNIT I

Introduction. General information. Precautions, contraindications. Antimicrobial agents Definitions; factors contributing to treatment success. Age, sex, species and water quality indications.

UNIT II

Antibacterial agents: general principles, classification. Antibiotics of different classes, cell wall synthesis inhibitors, inhibitors of protein synthesis, Bacterial DNA gyrase and topsoisomerase inhibitors and other miscellaneous antibiotics. (Sulfonamides, Fluoroquinolones,Metronidazole, Penicillins, Cephalosporins, Polypeptide and glycopeptide antibiotics, Aminoglycosides, Tetracyclines, Chloramphenicol & relatives, Macrolides, Nitrofurans). drug-resistance and environmental factors.

Antifungal agents, (Polyene antibiotics, Synthetics) antiprotozoan drugs and antihelmintics, Dyes.

UNIT IV

Antiseptics and disinfectants. Herbal formulations, Phytopigments, growth promoters Osmoprotectants.

UNIT V

Immunostimulants, vaccines probiotics and bioremediators – Principles, Mechanism of action, sources development of formulations. Steps in vaccine production and recent advances in vaccine research.

PRACTICAL

Antibiogram preparations; Pharmacy Preparation of different drugs, disinfectants and chemicals; Estimation of MIC

and MCC. Estimation of different antibiotics in water, blood and tissues. Experiments on withdrawal time from fish tissues.

Suggested Readings:

1. Applied Fish Pharmacology. Brown KMT. 2000. Aquaculture Series 3, Kluwer.
2. Fish Disease, Diagnosis and Treatment. Mosby-Year Book. Richard DH, Mary JM, Richard AH & Pamela CC. 2005.
3. Pharmacology. Lippincott Williams & Wilkins. Stoskopf MK. 1993.
4. Fish Medicine, Stoskopf MK. 1993. WB Saunders.
5. Fish Disease: Diagnosis and Treatment. Noga EJ. 1996. Blackwell. Stockoff MK. 1993.

BFSC 608. AQUATIC POLLUTION AND COASTAL ZONE MANAGEMENT (2+1)

THEORY

UNIT I

Classification of pollution – Physical, chemical and biological classification of water pollution – description of terminologies. Sewage and domestic wastes-composition and pollution effects-sewage treatement 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 plants nutrients: Eutrophication; Red tides and fish kills.

UNIT II

Pesticide types and categories; inorganic pesticides, Organi-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Biioaccumulation 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; Treatement 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 Biocorrosion; 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.

UNIT IV

Environmental Impact Assessment for fisheries and aquaculture projects. Anthropogenic activities and their impact on coastal zones; aquaculture, waste disposal, property and infrastructure development, ports and shipping, tourism (beach and excavations, water supply projects. Goals and purposes of CZM. Management methods and information: public awareness and environment policy, general coastal zone programs, shore lands management, coastal water basin protection, coastal water quality protection, harvestable resources, and ecosystem restoration. Coastal Regulation Zone (CRZ) Act. Integrated Coastal Zone Management (ICZM). International treaties and conventions. Preparation of projects bases on the provided Guidelines and Standards for Coastal Projects aquaculture, agriculture, estuarine fold protection, sewage treatment systems, solid waste disposal, Urban run off, Power plants disasters, etc..

PRACTICAL

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; Colliform 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.

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.

BFSC 609. FISHERIES EXTENSION EDUCATION (2+1)

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.

UNIT II

Fisheries extension methods-individual, group and mass contact methods and their effectiveness Audio visual aids-definitions advantages and disadvantages Classification and choice of audio visual aids Cone of experiences of experiences and criteria for selection and evaluation of audio visual aids Video conferencing- factor influencing their selection and use.

UNIT III

Technology- Characteristics of technology, transfer of technology process. Important TOT Programmes in fisheries. Role of NGO's and SHG's in Fisheries. Fisheries co-management.

UNIT IV

Adoption and Diffusion of innovation-adoption and diffusion process-adopter categories and barriers in diffusion of fisheries innovations. Communication process-Berlo's model and barriers to communication.

UNIT V

Extension programme 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 Theories of learning –learning experience –learning situation.

PRACTICAL

Collection of socio economic data from fishing villages. Study of social issues /problems through participatory and rapid rural appraisal techniques. Assessment of development needs of community and role of formal and non formal governmental organizations through stake holders' analysis .Case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programmes and success stories. Practical exercises on conducting/demonstrating different fish farmers meetings. Handling of audio visual equipments-Tape recorder-Public address system-Overhead projector- LCD, Slide Projector. Planning, preparation and presentation of Posters, Flashcards, folders, leaflet, charts. Organisation of an audio visual programmes. Preparation and presentation of radio script and Television talk.

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.

NON CREDIT COURSES (COMPULSORY)

BFSE 109. PHYSICAL EDUCATION (0+1)

Introduction to physical education: definition, scientific principles, objectives, scope, history, development and importance; physical culture, training and health; Fartlek training and Circuit training. Body mechanism and body type: Kretchmark's and Sheldon's classification. Theories of learning; Exercises for good posture; exercises to develop physical fitness -components, speed, strength, endurance, power, flexibility, agility, coordination and balance; Test and measurement in physical education: physical fitness test, motor fitness test, cardiovascular efficiency test and physical fitness index; aerobic and anaerobic exercises; Calisthenics, weight training, circuit training, interval training, far trek training, pressure training and resistance training; Importance of Asanas and Surya namaskar. Free hand exercises and Yoga. Recreation: definition, agencies promoting recreation, camping and recreation. Governance of sport in India; Conduct of sporting event, important national events; Drawing of fixtures and organisation tournaments; Rules and regulations, Coaching and skills development of major games; Rules and regulations, coaching and skills development of athletic events.

BFSE 209. SWIMMING (0+1)

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.

BFSE 308. INTRODUCTION TO ENVIRONMENTAL SCIENCES (3+0)

Definition, scope and importance - Natural resources, land – forest – water, mineral and food – energy resources – conservation of natural resources – equitable use for sustainable lifestyles – Natural ecosystems – type, concept, structures, function and management – conservation of water resources and disaster management. Social issues, sustainable development, and urban problems, rehabilitation and resettlement of issues – Environmental ethics, climate change and cause and environmental protection acts. Population – growth, explosion, family welfare programmes and environmental relation. Human rights, women and child welfare and role of information technology in environmental monitoring with case studies.

BFSE 309. COMMUNICATION SKILLS (0+1)

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. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organising seminars and conferences.

BFSE 409. RURAL SOCIOLOGY AND PSYCHOLOGY (1+0)

Rural Sociology : meaning, scope and importance, features of rural society Anthropology, socio - economic and demography of fishers, migration and patterns of settlement Social groups and Social classes. Caste and Class among fishers. Value system - Norms, Customs among fishers and their importance. Social values and Culture among fishers and their importance. Village level institutions - meaning, types and role in fisheries development. voluntary organizations - meaning, types and role in fisheries development. Leadership – meaning, identification and training, qualities and roles of leaders and use of local leaders in fisheries development. Social change and Social control. Social problems and Conflicts in fisheries. Gender issues in fisheries. Psychology: concepts, principles, scope and importance in fisheries extension. Intelligence - meaning, scope , types and importance. Personality - meaning, scope, types and importance. Perception - meaning, scope , types and importance Motivation - meaning, scope , types and importance. Learning, learning experience, learning situation.

BFSE 509. FIRST AID TRAINING (0+1)

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 bums 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.