VIDYASAGAR UNIVERSITY

REGULATIONS, CURRICULUM & SYLLABUS

For

Bachelor of Fishery Science (B.F.Sc.)

(w.e.f. Academic Year 2021-2022)

Bachelor of Fishery Science (B. F. Sc.)

Regulations, Curriculum and Syllabus

(w.e.f. Academic Year 2021-2022)

As per recommendations of Vth Deans' Committee of

Indian Council of Agricultural Research (ICAR)

VIDYASAGAR UNIVERSITY

Paschim Midnapore 721102, West Bengal

REGULATIONS

1. Title and Commencement:

1.1 These Regulations shall be called The Academic Regulations for '**BACHELOR OF FISHERY SCIENCE (B.F.SC.)** 4-YEAR UNDERGRADUATE DEGREE PROGRAMME, 2021-22 UNDER VIDYASAGAR UNIVERSITY' for obtaining Bachelor Degree in the Fishery Science under Semester system.

1.2 These Regulations shall apply to the students admitted in B. F. Sc. from the Academic Year **2021 – 2022** onwards.

2. Degree Nomenclature:

Bachelor of Fishery Science (B. F. Sc.)

3. Duration of the Degree Programme

3.1 The duration of the Programme is **EIGHT (08)** consecutive **SEMESTERS** of six months each *i. e.,* **FOUR (04) YEARS**.

3.2 A candidate shall have to clear all the Semesters maximum within **SIX YEARS** from the academic year of his/her first admission and registration to the B.F.Sc. Programme under Vidyasagar University failing which enrolment of the candidate shall stand cancelled.

3. Definitions

Academic Year: The 'Academic Year' shall ordinarily be formed as per Vidyasagar University rules.

Semester: An academic term consisting of not less than 90 instructional days, excluding days of final theory examinations.

Credit Hour: Each credit hour will be equivalent to one-hour lecture of theory or two hours of laboratory work for practical per week. It is also known as semester credit or credit.

Course: A course is a unit of instruction or a segment of subject to be covered in a semester. It has a specific number, title and credits.

Grade Point of a Course: Each course will be evaluated for 100 marks irrespective of the credits (theory or practical or theory and practical combined as per credits) for awarding grade point. The grade point shall be rounded to the second decimal place.

Credit Point of a Course: The product of credit hours and grade point obtained by the student in each course.

Grade Point Average (GPA): It is the quotient of the total credit points both in theory and practical of various courses obtained by a student at the end of each semester divided by the

total evaluated credit hours taken by the student in that semester. The grading is done on a 10-point scale. The GPA is to be rounded to the second decimal place.

Overall Grade Point Average (OGPA): It is the quotient of cumulative credit points obtained by a student in all the subjects both in theory and practical examinations taken by him/her from the beginning of the first academic year of the degree course divided by the total evaluated credit hours of all the subjects which he/she had completed up to the end of a given semester. It determines the overall performance of a student in all the subjects taken during entire course curriculum. The OGPA is to be rounded to the second decimal place. The Overall Grade Point Average obtained by a student on a 10-point scale is converted to percentage of marks by dividing the OGPA by 10 and multiplying with 100.

Grade Card or Marksheet: Based on the grade earned, a grade card or marksheet shall be issued after every semester. The grade card shall display the course details (code, title, marks, number of credits, grade secured) along with GPA and OGPA where applicable.

4. Admission

4.1 The admission to undergraduate degree programmes in B. F. Sc. will be governed by the guidelines of the Vidyasagar University and that of the Department of Higher Education, Govt. of West Bengal as laid down from time to time.

4.2 Age: Not less than 17 years as on 31st December in the year of application.

4.3 The candidate must pass the Higher Secondary (10+2) or its equivalent examinations with **Physics, Chemistry, Biology and English** as compulsory subjects with individual pass marks (in both theory and practical wherever applicable) in all the above four subjects in regular class mode.

4.4 The selection of students for admission will be done as per the merit list. The merit list will be prepared according to percentage of total marks obtained in the subjects of H.S. (10+2) or its equivalent examinations as stated above or through Entrance Examination or as laid down by Vidyasagar University from time to time.

4.5 A candidate shall be allowed to pursue any one of the degree undergraduate programme of the university at a time, not more than one.

4.6 Admission to the 1st Semester shall not be considered after the commencement of the classes.

5. Registration

5.1 Registration is mandatory for prosecuting studies. The registration for UG Degree programme will be governed by the University Regulations relating to Registration.

5.2 A student shall have to submit Registration Form only once at the time of entry to the UG Courses. He / She shall not be required to renew the registration at any subsequent stage.

5.3 A candidate provisionally admitted to B.F.Sc. degree but not registered under Vidyasagar University shall not be allowed to sit for 1st Semester Examination.

5.4. A candidate not being able to complete the programme within the Six subsequent Academic Years of his/her admission, the Registration of the candidate shall be treated as cancelled.

5.5. Migration/ Transfer of any student studying B.F.Sc. in any College affiliated to Vidyasagar University is not allowed during entire degree programme. Student shall not be allowed to change the college in the middle of his/her degree programme.

6. Attendance

6.1 A student having at least 75% attendance of scheduled theory and practical classes separately shall be allowed to sit for the concerned Semester Examination subject to the fulfilment of other conditions as laid down in the regulations.

6.2 Relaxation in attendance for NCC, NSS and Co-curricular activities is admissible as per University regulations subject to prior approval of College Authority.

6.3. The minimum attendance prescribed for Student READY programmes is 90%. Apart from medical ground no relaxation is allowed.

7. Course & Curriculum

7.1 Course of Study: Degree Course of B. F. Sc. shall comprise of a course of study consisting of Curriculum and Syllabi spread over four academic years including Student READY Programme. Each Course is allotted with credit-hour (s) of theory and practical classes. Course may be "Credit Course"/ "Non Credit Course". The Student READY Programme (SRP) is offered in two Semesters in the final year of the degree programme i.e., in Semester-VII **SRP-IPA (In Plant Attachment)** and in Semester-VIII **SRP - RFWEP (Rural Fisheries Work Experience Programme)**. Semester VIII consists of 3 course paper and Student Ready Experimental Module which include Skill development of the students in Experimental learning program, planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency.

7.2 The details of the Courses, Credits and Syllabi are framed in concurrence with the Vth Deans' Committee Recommendations by ICAR, 2017 and shall be prescribed by the University from time to time.

7.3 Medium of Instruction: Medium of instruction shall be English

7.4 Advisory System: The students after admission to B.F.Sc. programme shall be divided into different batches of convenient size by the College Authority and each batch shall be assigned a Student Advisor, one faculty member designated for the same. Among other things, the Advisors shall help the students in planning their academic programme.

7.5 Curriculum and Credits Requirement

The total credit requirement for the B. F. Sc. undergraduate degree programme shall be **183 credits** including **143 Instructional Credits** (Evaluated) + **20 for SRP-IPA Programme** (Semester-VII) + **20 SRP - RFWEP Programme** (Semester-VIII) + **3 Compulsory Non-credit courses** (Non-Evaluated Course).

8. Examination and Evaluation System

8.1 Date of Examination:

Exact dates and the schedule of examination shall be notified by the Controller of Examinations, Vidyasagar University. In the event of any unforeseen exigency the Controller of Examinations shall be competent for any adjustment in the prescribed schedule.

8.2 Schedule of Examination:

The schedule of examinations of B.F.Sc. consists of Internal and External Examinations. End Semester Examination (External) shall be conducted at the end of the academic activities of the respective Semester. There shall be one Midterm (Internal) examination to be conducted by the Colleges offering the course after completing 60% of the course in a Semester.

The details of examination are given below:

External Theory - 50%
Internal Theory + Practical - 50%

Course with both theory and practical: ***Total marks: 100***

- Theory: 80
  - (i) End Semester Examination = 50 marks
  - (ii) Midterm / Internal Assessment = 30 marks
- End Semester Practical Examination = 20 marks

Course with only theory: ***Total marks: 100***

- (i) End Semester Examination: = 50 marks
- (ii) Midterm / Internal Assessment: = 30 marks
- (iii) Assignment = 20 marks

Course with only Practical: ***Total marks: 100***

- (i) End Semester Practical Examination = 50 marks
- (ii) Midterm/Internal Assessment = 30 marks
- (iii) Assignment / Practical Note Book = 20 marks

8.3 Midterm (Internal) Examination: There shall be one Midterm (Internal) examination comprising of objective and subjective questions in the ratio of 40:60. The midterm examination shall be conducted by the concerned college offering B.F.Sc. programme at least after 60% completion of respective course. The Principal/ Officer In-charge of the respective college shall be responsible for conducting examination and providing the marks to the Controller of the Exanimation, Vidyasagar University maintaining the confidentiality of the examination. The modalities of such assessment be recorded and documents will be preserved by the respective college and those must be placed before any committee or team constituted by the university for verification.

8.4 End Semester (External) Examination: The End Semester (External) Examination An examination conducted by the University in each course for which an external examiner shall set the question paper (based on the Syllabus/Lecture Outlines of the concerned course) and also evaluate the answer papers as per the schedule of examination during the period scheduled by the Vidyasagar University at the end of each semester. End Semester (External) Examinations shall be conducted by the University as per the examination rules & regulations of Vidyasagar University. The date and schedule of end semester examination shall be determined by the Controller of Examination, Vidyasagar University

8.5 Practical Examination and Class Assessment/Assignment: There shall be one Practical Examination in each course at the end of Semester before the end of instructional days. Practical examination shall be conducted by the respective College offering B.F.Sc. programme in presence of expert/ evaluator nominated by the Vidyasagar University. The Principal/ Officer In-charge of the respective college shall be responsible for conducting examination with intimation to the University and providing the marks to the Controller of the Exanimation, Vidyasagar University maintaining the confidentiality of the examination. The modalities of such assessment be recorded and documents will be preserved by the respective college and those must be placed before any committee or team constituted by the university for verification.

8.6 Hour of End Semester Examination:

a. External Examination (**Theoretical) paper** of full marks **50,** duration **2** hours.
b. Midterm Examination (**Theoretical)** papers of full marks **30,** duration 1 hour.
c. Practical / Assignment **(Internal)** of full marks **20,** duration **2** hour.

8.7 Eligibility criteria of examination and types of assessment:

A candidate shall be eligible for appearing at any of the semester of examination fulfilling the following essential condition:

1. A student must have at least 75% class attendance (theory and practical separately).
2. Unless a student appears for the midterm examination and practical examination, the student should not be permitted to appear for the Semester Final Theory examinations in the course concerned.
3. Student shall have to fill-up the examination form of the University paying the required fees as stipulated by the Vidyasagar University from time to time.
4. Registration is mandatory prior to form fill-up for the 1st Semester Examination.
5. Admit card shall be issued by the Controller of Examinations before the End Semester Examination and is mandatory for appearing at the examination.

8.8 Evaluation / Grading System:

Based on the performance of the students, each student will be awarded Grade in subjects at the end of the semester examination following grading system on the base of TEN (10). On the basis of Cumulative Grade Point Average the student shall be awarded the Division to corroborate with the traditional scoring system.

i. **Grade Point** in a course shall be the total marks obtained by a student out of 100 divided by 10
ii. **Credit Point** is the Grade Point of the course multiplied by course credit.
iii. **Total Credit Point** shall be the sum of credit point secured by the student.
iv. **Grade Point Average (GPA)**shall be the sum of the total credit point earned divided by the sum of credit hours
v. Overall Grade Point Average (OGPA) shall be the grand total of credit points earned divided the grand sum of credit hours

Degree	Percentage of Marks Obtained	Conversion into Points
B.F.Sc.	100	10 Points
	90 to <100	9 to <10
	80 to <90	8 to <9
	70 to <80	7 to <8
	60 to <70	6 to <7
	50 to <60	5 to <6
	<50 (Fail)	<5
	Eg. 80.76	8.076
	43.60	4.360
	72.50 (but shortage in attendance)	Fail (1 point)

GPA = Total points scored / Total credits (for 1 semester)
OGPA = ∑ Total points scored / Course credits
% of Marks = OGPA/10 x 100

Classification of Successful Candidates: The successful candidates who after completion of the graduation requirements, have secured a CGPA of 5.00 or more in the 10.00 point scale shall be classified as under:

OGPA	Division
5.00 – 5.99	Pass
6.00 – 6.99	II division
7.00 – 7.99	I division
8.00 and above	I division with distinction

8.9 Promotion:

i. A candidate has to secure **minimum of 50% marks** of each course including the **minimum of 30% marks in end semester theory examination and 50% marks in practical examination** in order to qualify for the next semester.
ii. Progression to the next higher semester shall be allowed with maximum upto 2 (two) supplementary courses in a semester which to be cleared in corresponding end semester examinations. Candidate shall have two chances to clear supplementary in the subsequent examinations.
iii. A candidate shall have to clear all the Semesters maximum within **SIX YEARS** from the academic year of his/her admission and registration to the B.F.Sc. Programme under Vidyasagar University failing which enrolment of the candidate shall stand cancelled.
iv. The candidates remaining absent in the end semester theory examination will be marked as **ABSENT** and the candidate shall not be eligible to qualify for marks processing. The marks obtained in Internal Assessment shall be retained for the entire duration of his/her enrolment.
v. If a candidate secure pass marks in Practical Paper(s)/Project Work but fails to secure pass marks in theoretical papers, the marks of Practical Paper(s)/Project Work along with Internal Assessment of theoretical papers shall be retained.
vi. All backlog papers from 1st Semester to 6th Semester must be cleared before being promoted to **7th Semester.** Only after clearance of all the supplementary student shall qualify to attend the Student READY programme.
vii. A student must secure **OGPA more than 5.00 out of 10.00** at the end of the degree programme to be eligible to get Bachelor of Fishery Science degree.

9. Supplementary Examination:

i. A candidate who fails to secure pass marks in one or more courses maximum upto two courses of a Semester may appear in those paper(s) during Supplementary Examination when the concerned End Semester Examination will be held next.
ii. A candidate shall have to clear supplementary papers within two consecutive chances including his / her first appearance in the concerned End Semester Examination.
iii. A **Special Supplementary** examination will be held for **3rd year students** who have arrear paper only for **6th semester** to qualify them for Student READY programme.

Foot Note:

a) Principal / HOD of concern college shall ensure the coverage of syllabus.
b) End term theory and practical paper to be set by external examiner as per University regulation.
c) Evaluation of course paper to be done as per Vidyasagar University rules.
d) Practical examination shall be conducted by Internal and External teacher recommended by the BOS

SEMESTER WISE DISTRIBUTION OF COURSES

SEMESTER-I

Sl. No.	Course No.	Course Title	Credit hour
1	BFSC-101	Principles of Aquaculture	2 (1+1)
2	BFSC-102	Meteorology, Climatology and Geography	2 (1+1)
3	BFSC-103	Soil and Water Chemistry	3 (2+1)
4	BFSC-104	Fundamentals of Microbiology	3 (2+1)
5	BFSC-105	Fundamentals of Biochemistry	3 (2+1)
6	BFSC-106	Taxonomy of finfish	3 (1+2)
7	BFSC-107	Information and Communication Technology	2 (1+1)
8	BFSC-108	Taxonomy of Shellfish	2 (1+1)
9	BFSC-109	Fish Nutrition	1 (1+0)
10	BFSC-110	Swimming	1 (0+1)*
		Total	**21 (12+9)**

***CNC= Compulsory Non- credit Course (Non-Gradial)**

SEMESTER-II

Sl. No.	Course No.	Course Title	Credit hour
1	BFSC-201	Limnology	3 (2+1)
2	BFSC-202	Aquatic Ecology, Biodiversity	2 (1+1)
3	BFSC-203	Fresh Water Aquaculture	3 (2+1)
4	BFSC-204	Aquaculture in Reservoirs	2 (1+1)
5	BFSC-205	Statistical Methods	3 (2+1)
6	BFSC-206	Anatomy and Biology of Finfish	3 (2+1)
7	BFSC-207	Anatomy and Biology of shellfish	2 (1+1)
8	BFSC-208	Food Chemistry	3 (2+1)
9	BFSC-209	Physical Education, First Aid & Yoga Practices	1 (0+1)*
10	BFSC-210	Environmental studies	3 (2+1)
		Total	**24 (15+9)**

***CNC= Compulsory Non- credit Course (Non-Gradial)**

SEMESTER-III

Sl. No.	Course No.	Course Title	Credit hour
1	BFSC-301	Fish Immunology	2 (1+1)
2	BFSC-302	Marine Biology	3 (2+1)
3	BFSC-303	Fishery Oceanography	2 (1+1)
4	BFSC-304	Fish food Organisms	2 (1+1)
5	BFSC-305	Ornamental fish Production and Management	2 (1+1)
6	BFSC-306	Genetics and Breeding	2 (1+1)
7	BFSC-307	Physiology of finfish and shellfish	3 (2+1)
8	BFSC-308	Inland Fisheries	3 (2+1)

9	BFSC-309	Aquaculture Engineering	3 (2+1)
10	BFSC-310	Structural and Spoken English	2 (1+1)*
		Total	**22 (13+9)**

***CNC= Compulsory Non- credit Course (Non-Gradial)**

SEMESTER-IV

Sl. No.	**Course No.**	**Course Title**	**Credit hour**
1	BFSC-401	Chemotherapy and Drug Administration in Aquaculture	2 (1+1)
2	BFSC-402	Fish and Shellfish Pathology	3 (2+1)
3	BFSC-403	Finfish Hatchery Management	3 (2+1)
4	BFSC-404	Shellfish hatchery Management	2 (1+1)
5	BFSC-405	Fish Nutrition and Feed Technology	3 (2+1)
6	BFSC-406	Freezing Technology	2 (1+1)
7	BFSC-407	Fish Canning Technology	2 (1+1)
8	BFSC-408	Navigation and Seamanship	2 (1+1)
9	BFSC-409	Fishing Craft Technology	2 (1+1)
10	BFSC-410	Communication Skills and Personality Development	1 (0+1)
		Total	**22 (12+10)**

SEMESTER-V

Sl. No.	**Course No.**	**Course Title**	**Credit hour**
1	BFSC-501	Microbial and Parasitic Diseases of Fish & Shellfish	3 (2+1)
2	BFSC-502	Fish Toxicology	2 (1+1)
3	BFSC-503	Coastal Zone Management & Disaster Management	3 (2+1)
4	BFSC-504	Coastal Aquaculture and Mariculture	3 (2+1)
5	BFSC-505	Aquatic Mammals, Reptiles and Amphibians	1 (1+0)
6	BFSC-506	Marine Fisheries	3 (2+1)
7	BFSC-507	Fish Packaging Technology	2 (1+1)
8	BFSC-508	Fish By-Products and Waste Utilization	2 (1+1)
9	BFSC-509	Fishing Gear Technology	2 (1+1)
10	BFSC-510	Fishing Technology	2 (1+1)
		Total	**23 (14+9)**

SEMESTER-VI

Sl. No.	**Course No.**	**Course Title**	**Credit hour**
1	BFSC-601	Aquatic Pollution	2 (1+1)
2	BFSC-602	Introduction to Biotechnology and Bioinformatics	2 (1+1)
3	BFSC-603	Fish Population Dynamics and Stock Assessment	3 (2+1)
4	BFSC-604	Fish Products and Value Addition	3 (2+1)
5	BFSC-605	Microbiology of Fish and Fishery Products	3 (2+1)
6	BFSC-606	Fisheries Economics	3 (2+1)
7	BFSC-607	Fisheries Co-operatives and Marketing	2 (1+1)

8	BFSC-608	Fisheries Extension Education	2 (1+1)
9	BFSC-609	Fisheries Policy and Law	1 (1+0)
10	BFSC-610	Fisheries Business Management and Entrepreneurship Development	1 (1+0)
		Total	**22 (14+8)**

SEMESTER-VII

Sl. No.	**Course No.**	**Course Title**	**Credit hour**
1	BFSC-701	In-plant attachment [+]	10 (0+10)
2	BFSC-702	Rural fisheries Work Experience [+]	8 (0+8)
3	BFSC-703	Study Tour (in and outside State) [++]	2 (0+2)
		Total	**20 (0+20)**

[+]for 8 weeks; [++]for 4 weeks

SEMESTER-VIII

Sl. No.	**Course No.**	**Course Title**	**Credit hour**
1	BFSC-801	Refrigeration and Equipment Engineering	3 (2+1)
2	BFSC-802	Fish Pharmacology	3 (2+1)
3	BFSC-803	Quality assurance of Fish and Fishery Products	3 (2+1)
Student READY Experiential Module (concurrent with the semester) This will include capacity building and skill development of the students in planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency.			
4	BFSC-804	Skill Development (for one week)	5 (0+5)
5	BFSC-805	Experiential Learning Programme	12 (0+12)
6	BFSC-806	Project Work	2 (0+2)
7	BFSC-807	Seminar	1 (0+1)
		Total	**29 (6+23)**

SEMESTER WISE DETAIL SYLLABUS

Semester-I (Total- 22 Credit : 13+9)

Course: BFSC-101: Principles of Aquaculture 2 (1+1)

Theory

Definition, scope and history of aquaculture: Present global and national scenario. Aquaculture vs Agriculture. Systems of aquaculture - pond culture, pen culture, cage culture, running water culture and zero water exchange system. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water. Principles of organic aquaculture. Pre-stocking and post stocking pond management. Carrying capacity of pond, factors influencing carrying capacity. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integrated culture systems. Water and soil quality in relation to fish production. Physical, chemical and biological factors affecting productivity of ponds.

Practical

Aquaculture production statistics- world and India. Aquaculture resources of world and India. Components of Aquaculture farms. Estimation of carrying capacity. Practices on pre-stocking and post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH_3, Organic matter, CO_2). Analysis of manure.

Reference Books:

1. Ayyappan, S., 2011.Handbook of Fisheries and Aquaculture, ICAR Publications, New Delhi.
2. Rath, R.K., 2011. Fresh water Aquaculture, Scientific publications.

Course: BFSC-102: Meteorology, Climatology and Geography 2 (1+1)

Theory:

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms. Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients. Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. monsoon winds; land and sea breeze. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm

centre; hurricane, sea, swell and surge; hurricane warning. Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape.

Practical:
Graphic representation of structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Precipitation: measurement of rainfall using rain gauge. Atmospheric pressure measurement: fortin's mercurial barometer; Aneroid barometer. Isobars: Wind observation and measurement: wind vane; cup anemometer. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Geographical terms used in landscape.

Reference Books
1. Don, William L. 1965. *Meteorology.* Third Edition. McGraw-Hill Book Company, New York.
2. Anandeshwari Awasthi. 1995. *Indian Climatology.* APH Publishing Corporation, New Delhi.
3. *The Oxford School Atlas*. 1995. Oxford University Press, Delhi

Course: BFSC-103: Soil and Water Chemistry 3 (2+1)

Theory:
Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry: volumetry and gravimetry. Solutions: standard solutions, titration, indicators, dilute solutions, units of concentrations; standard curve; nomograph. Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters: surface water, ground water and sea water. Dissolved gasses: Factors affecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture. Soil Chemistry: origin and nature of soils. Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon-Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, alkali soils, acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soil samples. Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil and water amendments: application of limes manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

Practical

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

Reference Books

1. Boyd, C.E. 1990. Water Quality in Ponds for Aquaculture. Alabama Agricultural Experimental Station, Auburn University, Alabama, USA.
2. Harry O. Buckman and Nyle C. Brady. 1963. The Nature and Properties of Soils. The Macmillan Company, New York.
3. APHA. 2019. Standard Methods for the Examination of Water and Wastewater. 19th Edition, American Public Health Association, Washington.
4. Chattopadhyay, G.N. 1998. Chemical analysis of Fish Pond Soil and Water. Daya Publishing House, Delhi.
5. Hobart, H. Willard, L., Merritt, Jr., John A. Dean and Frank, A. Settle, Jr. 1986. Instrumental Methods of Analysis. Sixth Edition. CBS Publishers and Distributors, Delhi.
6. Ramadhas, V. and R. Santhanam. 1996. A Manual of Methods of Seawater and Sediment analysis. Fisheries College & Research Institute, Tuticorin.

Course: BFSC-104: Fundamentals of Microbiology 3 (2+1)

Theory:

Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi and protozoa. Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining; enumeration of micro-organisms, culture preservation methods. Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids-types and their importance. Mutation – types and significance. Microbial ecology**:** Introduction and types of interaction, extremophiles and their significance. Aquatic Microbiology: Introduction and **s**cope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses; distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators. Economic significance of aquatic microbes.

Practical:
Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry- Determination of size of micro organisms (ocular, stage micrometers). Tools and techniques in sterilization methods: Filtration, dry heat, moist heat, chemical agents Cultivation technique: Media preparation, Isolation - pure culture, subculture. Observation of fungi, blue-green algae, and protozoans. Staining techniques for bacteria– simple, differential, structural and Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems. Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliforms. Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method.

Reference Books
1. Pelczar, Michael J. 1993. *Microbiology*. Tata McGraw-Hill publishing Company Ltd., New Delhi.
2. Volk, A.W. and Wheeler, M.F. 1980. *Basic Microbiology*. J.B. Lippincott Company, London.

Course: BFSC-105: Fundamentals of Bio- Chemistry 3 (2+1)

Theory
A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Carbohydrate chemistry: Structure, classification, functions (mono, di and polysaccharides) isomerism and mutarotation. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Protein chemistry: classifications and functions. Classification, structure, function and properties of amino acids. Essential and non essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Digestion and absorption of lipids. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids. Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones- chemistry and function. Structure and functions of fat and water soluble vitamins. Vitamins – classification- functions. Minerals – classification – functions. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Protein synthesis. Energy changes in chemical reactions, reversible and irreversible reactions in metabolism.

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

Reference Books
1. Leninger, A.L. 1990. *Biochemistry*, CBS publishers and Distributors Pvt. Ltd.,

Shahdara, Delhi.
2. Wilson, K. and Walker, J. 2000. *Practical Biochemistry:Principles and Techniques.* University of Cambridge, UK.
3. Eric, E. C., Paul K., Stum P.F., George, B. and Roy, H. D. 1995. *Outlines of Biochemistry,* John Wiley and Sons, Inc., Canada.
4. Palanivelu, S. and Shanmugavelu, S. 1993. *Principles of Biochemistry and Biotechniques.* Palani paramount publications, Madurai.
5. Prakash, M. and Arora, C.K. 1998. *Laboratory Instrumentation,* Anmol Publications Pvt. Ltd. New Delhi.

Course: BFSC-106: Taxonomy of finfish 3 (1+2)

Theory

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyo taxonomy, DNA barcoding, 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; Karyo taxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism; Visit to fish landing centres to study commercially important fishes and catch composition.

Reference Books

Nelson, J.S. 1994. *Fishes of The World. 3rd Edition*. John Wiley & Sons, Inc., New York.
2. Day, F. 1989. *Fishes – Vol.I.* Today and Tomorrow's Printers and Publishers, New Delhi.
3. Day, F. 1994. *Fishes – Vol.II*. Jagmander Book Agency, New Delhi.
4. Gunther, A.C.L.G. 1993. *An Introduction to The Study of Fishes*. Discovery Publishing House, New Delhi.
5. Lagler, K.F. *et al.* 1977. *Ichthyology*.1st Edition. John Wiley & Sons, Inc., New York.
6. Jayaram, K.C. 1998 .*The Freshwater fishes of the Indian Region*. Narendra Publishing House, Delhi.

Course: BFSC-107: Information and Communication Technology 2 (1+1)

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and

World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo's model, feedback and barriers to communication

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. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Reference Books

1. Gini Courter and Annette Marquis. 1999. *Microsoft Office Professional*. B.P.B Publication, New Delhi.
2. Jaggi,V.P. and Sushma Jain. 1993. *Computer for Beginners*. Academic Publications. New Delhi.
3. Peter Dyson and Pat Coleman. 2000. *Windows 2000 Professional*. B.P.B Publication, New Delhi.
4. Ram, B. 1997. *Computer Fundamentals*. New Age International Publishers, New Delhi.
5. Taxali, R.K. 1998. *PC Software for Windows Made Simple*. Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. Balaguruswami, E. 1991. *Programming on BASIC*. Tata McGraw- Hill Publishing Company, New Delhi.
7. Goel, S.K. 1999. *Computer and Internet Management Vol.1*. Rajat Publications, Delhi.

Course: BFSC-108: Taxonomy of Shell Fishes 2 (1+1)

Theory

Study of external morphology and meristic characteristics of Crustacea and Mollusca. Classification of Crustacea and 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 study of commercially important shellfishes.

Reference Books

1. Burukovskii, R.N. 1982. *Key to Shrimps and Lobsters*. Oxonian Press Pvt. Ltd., Delhi.
2. Kotpal, R.L. 1992. *Mollusca*. Rastogi Publications, Meerut.
3. Hochachka, W.P. 1983. *The Mollusca (Vol II*). Academic Press, London.
4. Kurian, K.V. and Sebastian, V.O. 1993. *Prawns and Prawn Fisheries of India*. Hindustan Publishing Corporation, New Delhi.
5. Subba Rao, N.V.S. 1989. *Handbook, Fresh Water Molluscs of India*. ZSI, Calcutta.
6. Narasimham, K.A. 2005. *Molluscan Fisheries of India*. B. R. Publishing, Delhi.

Course: BFSC-109: Fish Nutrition 1 (1+0)

Theory

Composition of fish with emphasis on nutritional value. Concept of Biological value, Protein Efficiency ratio, Net protein utilization. Amino acids of fish and shellfishes and importance of essential amino acids. Fish lipids: fatty acids, nutritional quality. Role of fish lipids in human nutrition. Non-protein nitrogen substances in fishes. Vitamins in fish: water soluble, fat soluble, significance in human nutrition. Minerals in fish: micro- and macro-elements, trace elements, significance in human nutrition. Other functional bio-molecules in fish – peptides, collagen and squalene. Effect of different kinds of cooking fish ie. curry, frying, steaming, smoking, fermentation on nutrition value.

Reference Books

1. Taneko Suzuki. 1981. *Fish & Krill Protein*: *Processing Technology*. Applied Science Publishers Ltd., London.
2. Joyce Nettleton. 1985. *Sea food Nutrition*. Van Nojhand Reinhold, Newyork.
3. Meera vashishit . 1998. *Food nutrition and processing* –Anmol publication pvt. Ltd.
4. Govindhan.T.K. 1985. *Fish processing Technology*. Oxford & IBH Publishing co., New Delhi.
5. Shahidi, F. and J.R. Botta. 1994. *Seafoods chemistry, Processing Technology and Quality*. Blakie Academic and Professional, U.K.
6. Swaminathan, M. 1985. *Hand book of Food and Nutrition* – The Bangalore Printing and Publishing Company, Ltd. Mysore road.

Course: BFSC-110: Swimming (Compulsory Non-Credit Course) 1 (0+1)*

Practical

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 andtheiruses;diving-stylesofdiving,rules,regulationsandprecautions. Methods of life saving in water; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulations and practice.

Semester-II (Total- 23 Credit: 14+9)

Course: BFSC-201: Limnology 3 (2+1)

Theory

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes - their origin and diversity. Famous lakes of the world and India; nature of Lake Environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary

productivity: Aquatic plants: characterstics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

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 fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Field visit to lotic and lentic water bodies.

Reference Books

1. Welch, Paul S. 1952. *Limnology.* McGraw-Hill Book Company, Inc., New York.
2. Horne, Alexander J. and Goldman, Charles R. 1994. *Limnology.* McGraw Hill Inc. New York.
3. Hutchinson, G. Evelyn. 1975. *A Treatise on Limnology:* Volume I (Parts 1 and 2), Volume II, and Volume III. Wiley Interscience, New York.
4. Hynes, H.B.N. 1972. *The Ecology of Running Waters.* University of Toronto Press, Toronto
5. Wetzel, Robert G. and Gene E. Likens. 1991. *Limnological Analyses.* Springer-Verlag, New York.

Course: BFSC-202: Aquatic Ecology and Biodiversity 2 (1+1)

Theory

Aquatic Ecology and Biodiversity: Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches, mangroves, coral reefs, flood plains, coastal wet lands, beels, oxbow lakes. Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Practical

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices.

Reference Books

1. Nair, Balakrishnan, N. and Thampy, D.M. 1980. *A Text Book of Marine Ecology*. The Macmillan Company of India Limited, Delhi.
2. Boaden, Patric J.S. and Raymond Seed. 1985. *An Introduction to Coastal Ecology* Blackie, Glasgow and London.
3. Odum, Eugene P. 1971. *Fundamentals of Ecology*. Third Edition. Nataraj Publishers Dehra Dun.
4. Chapman, V.J. 1977. *Ecosystems of the World.* Vol. I. *Wet Coastal Ecosystems*. Elsevier, New York.

Course: BFSC-203: Freshwater Aquaculture 3 (2+1)

Theory

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc. Nursery, rearing and grow-out ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods-Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture. Composite fish culture system of Indian and exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfish and murrels. Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

Practical

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

Estimation of live stock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

Reference Books:

1. Jhingran, V.G. 1998. Fish and Fisheries of India. Hindustan Publishing Corporation,

New Delhi.
2. Huet Marcel. 1972. Text book of fish culture. Oxford Fishing news books.
3. Santhanam, R., Sukumaran, N. and Natarajan, P. 1987. A manual of Aquaculture. Oxford- IBH, New Delhi.
4. Srivatsava. 1993. Freshwater Aquaculture in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Course: BFSC-204: Aquaculture in Reservoir 2 (1+1)

Theory

Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and post-impoundment stages and their significance in establishment of reservoirs fisheries. Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production. Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs Role of cage and pen culture in enhancement of fish production from reservoirs; history of cage culture, advantages of cage culture; selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system. Integration of cage culture with other farming systems. History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture.

Practical

Preparation of charts on the present situation of reservoirs fisheries productivity; detailed case studies of selected reservoirs on the changing trends in capture fisheries profile; drawing inferences from the analysis of data; suggestions for the sustainable development of reservoirs fisheries. Case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation.

Reference Books

1. Ayyappan, S., 2011. Handbook of Fisheries and Aquaculture, ICAR Publications, New Delhi.
2. Sugunan, V.V., 1995.Reservoir fisheries of India. FAO Fisheries Technical Paper. No. 345. Rome, FAO. 1995. 423 p.
3. Ahilan, B., 2013. Text Book on Fresh water Aquaculture, Daya publishing house.
4. Cage Aquaculture, 3rd Edition. Malcolm Beveridge, Black Well Publishing, Pp. 380.

Course: BFSC-205: Statistical Methods 3 (2+1)

Theory

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

frequency curve and Ogives. Important measures of central tendency - arithmetic mean median and mode. Relative merits and demerits of these measures. Important measures of dispersion, Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis. Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression, Length weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Practical

Construction of questionnaires and schedules. Diagrams and frequency graphs. Calculation of arithmetic mean, median, mode, range, mean deviation, variance, Standard Deviation. Exercises on probability, Binomial and Poisson distributions, Area of normal curve ,confidence interval for population mean, Test of hypothesis based on normal, t, and chi-square. Computation of Simple correlation and regression. Fitting of length - weight relationship in fishes.

Reference Books

1. Elhance, D.N. 1990. *Fundamentals of Statistics*. Kitthab Mahal, New Delhi.
2. Bailey Norman T.J. 1995. *Statistical Methods in Biology*. Cambridge University press, Cambridge.
3. Rangaswamy, R. 1995. *A Textbook of Agricultural Statistics*. New Age International, New Delhi.
4. Singh, Sukminder. 1984. *Statistical Methods for Research Workers*. USG Publishers, Ludhiana.

Course: BFSC-206: Anatomy and Biology of Finfish 3 (2+1)

Theory

Study of external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Practical

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

maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

Reference Books

1. Lagler, K.F. et al. 1977. *Ichthyology 2nd Edition*. John Wiley & Sons, Inc. Canada.
2. Bone, Q. *et al.* 1995. *Biology of Fishes*. Blackie Academic & Professional, London.
3. Kumar, S. and Tembhre, M. 1996. *Anatomy and Physiology of Fishes*. Vikas Publishing House Pvt. Ltd., New Delhi.
4. Munshi, J.S.D. 1995. *Fish Morphology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Course: BFSC-207: Anatomy and Biology of Shellfish 2 (1+1)

Theory

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

Practical

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

Reference Books

1. Bone, Q. et al. 1995. Biology of Fishes. Blackie Academic & Professional, London.
2. Kumar, S. and Tembhre, M. 1996. Anatomy and Physiology of Fishes. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Munshi, J.S.D. 1995. Fish Morphology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Course: BFSC-208: Food Chemistry 3 (2+1)

Theory

Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydrates: Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic. Lipids: metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Proteins: metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins. Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food

additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human nutrition.

Practical

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

Reference Books

1. Leninger, A.L. 1990. *Biochemistry,* CBS publishers and Distributors Pvt. Ltd., Shahdara, Delhi.
2. Wilson, K. and Walker, J. 2000. *Practical Biochemistry:Principles and Techniques.* University of Cambridge, UK.

Course: BFSC-209: Physical Education, First Aid and Yoga Practices 1 (0+1)
(Compulsory Non-Credit course)

Practical

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

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

Needandrequirementoffirstaid.FirstAidequipmentsandupkeep.Handlingandtransport of injured traumatized persons. Emergency procedure for suffocation, demonstration of artificialrespiration.Treatmentofinjuries(woundsandbleeding)methodsofdressingand bandages; first-aid procedure for injured bones. Handling unconsciousness; Treatment of bumsandscalds.Emergencyprocedureforpoisoningwithspecialreferencestosnakebite. Injuries accidents in fishing, fish processing factories, chemical laboratories and their treatments. Shock injuries tomuscles andjoints andtreatments. Sportsinjuries andtheir treatments.

Course: BFSC-210: Environmental Studies 3 (2+1)

Theory

Definition, scope and importance of ecosystem. Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefitsh and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems. Concept of an ecosystem. Producers, consumers and decomposers. Structure and function of different ecosystems, like Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-sports of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of a. Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Social Issues and the Environment: From Unsustainable to Sustainable development. Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. dyes. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Qualitative and quantitative test of different environmental parameters.

Reference Books

1. Don, William L. 1965. *Meteorology.* Third Edition. McGraw-Hill Book Company, New York.
2. Anandeshwari Awasthi. 1995. *Indian Climatology.* APH Publishing Corporation, New Delhi.
3. *The Oxford School Atlas*. 1995. Oxford University Press, Delhi

Semester-III (Total- 22 Credit: 13+9)

Course: BFSC-301: Fish Immunology 2 (1+1)

Theory

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types. epitopes, haptens. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells**.** Antigen-antibody reaction - Precipitin reactions, agglutination reactions, Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish- specific and non specific immune system. Pathogenicity and virulence. Sources of infection, transmission of disease producing organisms, portals of infection. Immunity to bacteria, fungi and parasites Role of stress and host defense mechanism in disease development. Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants – types, mechanism of action, modes of administration. Immuno-assays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

Practical

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

Reference Books

1. Pelczar, Michael J. 1993. *Microbiology*. Tata McGraw-Hill publishing Company Ltd., New Delhi.
2. Volk, A.W. and Wheeler, M.F. 1980. *Basic Microbiology*. J.B. Lippincott Company, London.
3. Ellis, A.E. 1990. *Fish Immunology*. John Wiley & Sons, New York.
4. Buchanan, R.E. and Gibbons, N.E. (Co-Eds.). 1975. *Bergey's Manual of Determinative bacteriology*. The Williams & Wilkins Company, Baltimore.
5. Swain, P., Sahoo, P.K. and Ayyapan, S. 2006. *Fish and Shellfish Immunology - An Introduction*. Narendra Publishing House, New Delhi.

Course: BFSC-302: Marine Biology 3 (2+1)

Theory

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, sea weeds, major zooplankton groups. Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries. Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation. Mud banks: formation, characteristics. Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms. Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species, Blooms, Red tides: cause and effects.

Practical

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

Reference Books

1. Fincham, A.A. 1984. *Basic Marine Biology.* British Museum (Natural History), Cambridge University Press, Cambridge, England.
2. Sverdrup, H.U., Martin W. Johnson and Richard, H. Flemming. 1962. *The Oceans: Their Physics, Chemistry, and General Biology.* Asia Publishing House, Bombay.
1. Ford, Timothy Edgcumbe. 1993. *Aquatic Microbiology: An Ecological Approach.* Blackwell Scientific Publications, Oxford, London.
2. Levinton, Jeffrey S. 1995. *Marine Biology: Function, Biodiversity, Ecology.* Oxford University Press, Oxford, England.

Course: BFSC-303: Fishery Oceanography 2 (1+1)

Theory

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; Major feature of topography and terminology; major divisions. Relief in Indian Ocean. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents - direct and indirect methods, drift currents Ekman spirals, upwelling, sinking, thermohaline circulation, El-Nino. Physical properties of sea water: salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity (definition only). General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses

of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO_2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans.

Practical
Field visits and operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water.

Reference Books
1. Reddy, M.P.M. 2000. *Descriptive Oceanography*. Oxford I.B.H. Ltd., New Delhi.
2. Sverdrup, H.U., Martin W. and Richard, H. Flemming. 1962**.** *The Oceans: TheirPhysics, Chemistry, and General Biology***.** Asia Publishing House, Bombay.
3. Grant Gross, M. 1985. *Oceanography.* Charles E. Merrill Publishing Company, Columbus.
4. Sharma, R.C. and M. Vatal (Mrs. M. Hukku). 1992. *Oceanography for Geographers*. Chaitanya Publishing House, Allahabad.

Course: BFSC-304: Fish Food Organisms 2 (1+1)

Theory
Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials - proximate composition of live feed. Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

Practical
Methods of collection and identification of different live food organisms. Laboratory scale culture of selected live food organisms (green algae, spirulina, chetoceros, rotifer, Moina, copepod). Evaluation of live food organisms. Decapsulation and hatching method of brine shrimp cyst.

Reference Books:

1. Ayyappan, S., 2011.Handbook of Fisheries and Aquaculture, ICAR Publications, New Delhi.
2. Rath, R.K., 2011. Fresh water Aquaculture, Scientific publications.
3. N. Arumugam, K.V. Jayashree, C.S. Tharadevi,. Home Aquarium and Ornamental Fish Culture, Saras Publication

Course: BFSC-305: Ornamental Fish Production and Management 2(1+1)

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

of freshwater and marine aquarium. Water quality management. Water filteration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

Practical

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

Reference Books

1. Dick Mills. (1998). Aquarium fishes, Dorling Kindersly Ltd, London.
2. Van Ramshorrt, J.D. 1978. The complete aquarium encyclopedia, Elseveir publishers.
3. Jameson, J.D. and Santhanan, R. 1996. Manual of ornamental fishes and farming technologies, Fisheries College and Research institute, Tuticorin
4. Stephen spottee.1993. Marine aquarium keeping. John wiley and sons, U.S.A.

Course: BFSC-306: Genetics and Breeding 2(1+1)

Theory

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over. Introduction to population genetics. Hardy- Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

Practical

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt.

Reference Books

1. Purdom, Colise 1993. *Genetics and Fish Breeding*. Chapman and hall, London.
2. Greg Lutz, C. 2001. *Practical Genetics for Aquaculture.* Fishing News Books, London.
3. Lakra, W.S. 2000. *Fish Genetics and Biotechnology*. CIFE. ICAR. Mumbai.
4. Sinnot, E.W., Dunn, L.C., and, Dobzhansky, T. 1992. *Principles of Genetics*, Tata McGraw hill publishing company, Ltd, New Delhi
5. Tave, D. 1995. *Selective Breeding Programmes For Medium Sized Fish Farms.* FAO Fisheries Technical Papers No. 352, Rome, FAO, 122 p.

Course: BFSC-307: Physiology of Finfish and Shell fish 3 (2+1)

Theory

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on physiology of fin and shellfishes. Stress related physiological changes. Structure and functions of important endocrine glands.

Practical

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

Reference Books

1. Evans, D.H.1993. *The Physiology of Fishes*. CRC Press, London.
2. Santosh Kumar and Manju Tembhre, M. 1996. *Anatomy and Physiology of Fishes*. Vikram Publishing House. Pvt. Ltd., New Delhi.
3. Chapman & Hall. 1995. *Environmental Biology of Fishes*. T...Press Ltd., Britain.
4. Moyle, B.P. and Joseph, J.C. 1988. *Fishes- An Introduction to Ichthyology*. John Wiley & Sons, Inc., New York.
5. Smith, L.S. 1999. *Introduction to Fish Physiology*. Narendra Publishing House, New Delhi. Experimental physiology by S.C. Rastogi.

Course: BFSC-308: Inland Fisheries 3 (2+1)

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery- present status of their exploitation and future prospects. Cold water fisheries of India.

Practical

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and

experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, net making yards.

Reference Books

1. Jhingran, V.G. 1991. *Fish and Fisheries of India.* Hindustan Publishing Corporation, New Delhi.
2. FAO. 1999. *Aquaculture Production Statistics 1988-'97*.
3. Jayaram, K.C. 1999. *The Freshwater Fishes of the Indian Region*. Narendra Publication, New Delhi.
4. Munro, S.I. 1982. *The Marine and Fresh Water Fishes of Ceylon*. Soni Reprints Agency, New Delhi.

Course: BFSC-309: Aquaculture Engineering 3 (2+1)

Theory

Definition, objectives and types of fish farms; fresh water, brackish water and marine farms. Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics. Land Surveying- definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey. Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling. Plane table surveying- instruments required, working operation, methods. Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour. Soil and its properties- classification of soil; soil sampling methods; three phase system of soil, definitions of soil properties and permeability of soil. Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish ponds, layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds; Types of ponds; nursing ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond *etc.*, construction ponds viz., marking, excavation etc., Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes. Water distribution system- canal, types of canals; feeder canal, diversion canal etc. Pipe line system, Water control structures- types of inlet and out let and their construction. Water budget equation, Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc., Hatcheries- site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc, Raceway culture system- site selection, layout plan, types of raceway culture system viz., parallel system, series system etc., Aerators- principles, classification of aerators and placement aerators. Pumps- purpose of pumping, types, selection of pump, total head, horse power calculation. Filters- types and constructions.

Practical

Evaluation of potential site for aquaculture. Calculation of area of regular and irregular plane surfaces, Trapezoidal and Simpson's rule, volume of regular and irregular shape as applied to stacks and heaps, calculation of volume of pond. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations- excavation, embankment, longitudinal slope and cross slope, calculation of volume of earth work as applied to roads and channels and water requirement calculation. Visit to different types of farms.

Reference Book

1. Anand, S. Upadhyay. 1994. *Handbook on Design Construction and Equipments in Coastal Aquaculture*. Allied Publishers Ltd. Mumbai.
2. Bose, A.N., Ghouse, S.N., Yang, C.T., Mitra, A. 1991. *Coastal Aquaculture Engineering*. Mohan Primlani for Oxford and IBH Publishing Co Private Ltd. New Delhi.
3. Fredrick, W.Wheaton. 1972. *Aquaculture Engineering*. John Wiley and Sons, New York.

Course: BFSC-310: Structural and Spoken English (Compulsory Non-Credit Course)

2 (1+1)

Theory

TEXT BOOK PRESCRIBED: ***English for Students of Science***
(Eds) A.Roy and P.L.Sharma.1991.
Orient Longman, New Delhi.

The following selections from the text book are to be covered during the semester

1. The year 2050- Reflections of a Futurist - Theodore J.Gordon
2. The Mushroom of Death- The World - A. Bandhopadhyay
   After a Nuclear War
3. The Miracle of Grass Krutch - Joseph Wook
4. Human Environment - Indira Gandhi
5. Experiment and Experience - W.R. Niblem.
6. Grief - Anton Chekou
7. The Discovery - Herman Ould

Practical

Introduction to spoken English – Improving Voice and speech – Phonetic symbols – Orthography – Ortheopy – Vowels and consonants – Spoken English – Practice by Using Audio- Visual aids. Verbal ability- Words often confused - Words frequently misspells- Antonyms- Synonyms- Homonyms- Homo Phones – Phrasal verbs- Redundant Words and Phrases- Idiomatic Languages- Exercises. Functional grammar and correct usage - agreement collective norms- Indefinite. Pronouns relative pronouns compound subject. Words that indicate parts or portion amount – sequence of tenses – infinitive phrases – split infinitives –

participles – adverbs – prepositional phrases. Writing skills – precise – summarizing – abstracting. Scientific/Technical report writing. Seminars and conferences. The style – importance of professional writing. Business correspondence. Group discussion – group dynamics – purpose – organization. Meeting – purpose – procedure – chairmanship – participation – Physical arrangements. Notices, agenda and minutes – exercises.

Reference Books

1. Anon. *How to Write and Speak Better*. Readers Digest Association Ltd.,New York.
2. Bansal, R.K. and Harrison, J.B. 1983. *Spoken English.* Orient Longman, New Delhi.
3. Krishna Mohan and Meena Banerji. 1990. *Developing Communication Skills.* Mac Millons India Ltd, New Delhi.
4. Narayana Swamy, V.R. 1979. *Strength in Your Writing.* Orient Longman, New Delhi.
5. Sharma, R.C. and Krishna Mohan. *Bussiness Correspondence and Report.* Tata McGraw-Hill Pub. Co., New Delhi.

Semester-IV (Total- 22 Credit: 12+10)

Course: BFSC-401: Chemotherapy and Drug Administration in Aquaculture 2 (1+1)

Theory

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc. Antibiotic resistance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoans. Antibiotics used in aquaculture. Biologics: Immuno-stimulants and vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/ formulation, mechanism of action, drug leaching, stabilizer, binders and dosage. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anesthetics, flesh color enhancers, Chemicals of therapeutic value, Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices, list of the drugs used in aquaculture with therapeutics

Practical

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

Reference Books:

1. Edward, J. Noga. 2010. *Fish diseases Diagnosis & Treatment*: 2nd edition. Wliiey Blackwell publications.
2. Brian Austin and Dawn Austin. 2007. *Bacterial fish pathogendiseases of Farmed and WildFish*: 4th edition. Praxis Publications, Chichester,UK.
3. Schaperclaus, W. et al, 1991. *Fish diseases: Vol.I.* Oxonian press pvt.ltd, New Delhi.

4. Jorge C. Eiros, et al. 2008. *Fish diseases: Vol.II*. Science publishers.
5. Shozo Egusa. 1991. *Infectious diseases offish*. Oxonian press pvt.ltd. New Delhi.

Course: BFSC-402: Fish and Shell fish Pathology 3 (2+1)

Theory

Definition, concept and significance of finfish and Shellfish diseases in aquaculture. Host, Pathogen and Environment Interaction. Disease development process. Stress in aquaculture and its role in disease development. Pathological processes: Cellular response to injury, Inflammatory response to diseases, Pathogencity mechanism of parasite, bacteria, virus and fungus. Case history and clinical sign in disease diagnosis. Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals and metabolites, free radicals, oxidants) soil and water parameters in fish health. Nutritional diseases, Non-infectious diseases.

Practical

Live and post mortem examination of fish and shellfish. Pathology of organ systems. Histopathology of normal and diseases fish and shellfish, Diagnosis of abiotic fish diseases, Nutritional diseases and Non-infectious diseases.

Reference Books

1. Roberts, R.J. (Ed.). 1989. Fish Pathology. Bailliere Tindall, New York.
2. Bell, T.A. and Lightner, D.V. 1988. *A Handbook of Normal Penaeid Shrimp Histology*. World Aquaculture Society, Baton Rouge, Louisiana.
3. Ferguson, H. 1989. *Systematic Pathology of Fish*. Lowa State University Press, Lowa.
4. Lightner, D.V. 1996. *A handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp*. World Aquaculture Society, Baton Rouge, Louisiana.
5. Takash Hibiya. 1982. *An Atlas of Fish Histology*: *Normal and Pathological Features*. Kodansha Ltd., Tokyo.

Course: BFSC-403: Finfish Hatchery Management 3 (2+1)

Theory

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warm water finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of

mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea hourse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps.

Practical

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

Reference Book:

1. Jhingran, V.G. Pullin, R.S.V. 1997. A hatchery manual for the Common, Chineseand Indian Major Carps. Asian Development Bank, International Center for Living Aquatic Resources Management, Philippines.
2. Chonder, S.L. 1994. Induced Carp Breeding. C.B.S. Publishing New Delhi.
Reference Books
3. Keshavanath and Radhakrishnan. 1990. Carp seed production technology, Asian Fishery Society, Indian branch, Mangalore.
4. Ramanathan, N. and Francis, T. 1996. Manual on breeding and larval rearing of cultivable fishes, Fisheries College and Research Institute, Tuticorin.

Course: BFSC-404: Shellfish Hatchery Management 2(1+1)

Theory

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachium rosenbergii*, *P. Vannamei*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe Crab, Sepia, Loligo, Cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon*. and *P. vannamei*. Induced maturation in *Penaeus monodon* and *P. Vannamei P. indicus* by eye stalk ablation. Reproductive physiology. Reproductive harmones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *Penaeus monodon* and *Macrobrachium rosenbergii.* Breeding and hatchery management of crabs lobster, mussel, edible and pearl oyster. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

Practical

Identification of brood stock and maturity stages of important crustaceans and mollusks. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon* P. vannamei. Identification of larval stages of important crustaceans and mollusks. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and

transportation of shrimp/prawn seed and brood stock. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.

Reference Books:

1. Joshua,K. et al. 1993. Shrimp Hatchery Operation and Management. Marine products Export Development Authority, Kochi, India.
2. Aquacop.1979. Mass production of *Macrobrachium rosenbergii* juveniles. CNEXO-COP. Tahiti French Polynesia.
3. Granvil, D. and Treece, Joe, M. Fox. 1993. Design, Operation and Training manual for an intensive shrimp hatchery- Institutional grant NA 16 RGO457-01to Texas A&M university, Sea grant college.
4. Silas, E.G. et al. (Eds.)1985. Hatchery production of penaeid prawn seed, Penaeus indicus. CMFRI.spl. publication.23. CMFRI. Kochi.
5. Thakur,N.K. et al. (Eds.) 1998. Culture of live food organisms for aqua hatcheries. Training manual. CIFE (ICAR), Mumbai.

Course: BFSC-405: Fish Nutrition and Feed Technology 3(2+1)

Theory

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning. Methods of feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants. Feed evaluation: feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutrional deficiency diseases.

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. Taneko Suzuki. 1981. *Fish & Krill Protein*: *Processing Technology*. Applied Science Publishers Ltd., London.
2. Joyce Nettleton. 1985. *Sea food Nutrition*. Van Nojhand Reinhold, Newyork.
3. Meera vashishit . 1998. *Food nutrition and processing* –Anmol publication pvt. Ltd.
4. Govindhan.T.K. 1985. *Fish processing Technology*. Oxford & IBH Publishing co., New Delhi.
5. Shahidi, F. and J.R. Botta. 1994. *Seafoods chemistry, Processing Technology and Quality*. Blakie Academic and Professional, U.K.
6. Swaminathan, M. 1985. *Hand book of Food and Nutrition* – The Bangalore Printing and Publishing Company, Ltd. Mysore road.

Course: BFSC-406: Freezing Technology 2 (1+1)

Theory

Introduction to freezing technology; characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants. Principles of low temperature preservations. Chilling of fish – methods and equipment for chilling; icing – quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Freezing of fish fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico– chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish for freezing. Changes that occur during frozen storage – microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments – polyphosphate, glazing, antioxidants, packaging; thawing of frozen fish – methods of thawing. Transportation of frozen fish, cold chain, quality control, HACCP in freezing industry.

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 ice plants, cold storages and freezing plants.

Reference Books

1. Borgstom.G.E.1962. *Fish as Food, Vol. I to Vol. IV,*. Academic Press, New York.
2. Regenstein, J.M. and Regenstein, C.E. 1991. *Introduction to Fish Technology.* An Osprey Book, Van, Nostrand, Reinhold, USA.
3. Balachandran, K.K. 2001. *Post – Harvest Technology of Fish and Fish Products.* Daya Publishing House, Delhi.
4. Ciobanu, A. et al. 1976. *Cooling Technology in the Food Industry.* Abacus Press, Abacus House, Speldhurst Road, Kent, England.
5. Graham Bligh . E. 1992. *Seafood Science and Technology*. Fishing News Books London.
6. Stansby,E. 1963. *Industrial Fishery Technology*. NOASEATLE Publishing Co.

Course: BFSC-407: Fish Canning Technology 2 (1+1)

Theory

Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials and sub materials, their characteristics and suitability for canning. Classification of foods based on pH, commercial sterility, Absolute sterility, pasteurisation and sterilization. Canning process, process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Principles of thermal processing. Heat resistance of micro organisms, heat penetration studies, mechanism of heat transfer. Cold spot and its importance, convection and conduction type of packs. Process calculation by general/ graphical methods, estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D

concept. Canning of commercially important fin fishes, shell fishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal. Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches.

Practical

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

Reference books

1. Balachandran, K.K. 2004. *Fish Canning Principles and Practices.* Central Institute of Fisheries Technology, ICAR, Cochin.
2. Footitt, R.J.& Lewis, A.S. 1995. *The Canning of Fish& Meat*. Blackie Academic professional.
3. Warne, D. 1988. *Manual on Fish Canning.* FAO Fisheries Technical Paper: 285.
4. Wheaton, F. W. and T. B. Lawson,. 1985. *Processing Aquatic Food Products*, A Wiely – Inter Science Publication. U.S.A.

Course: BFSC-408: Navigation and Seamanship 2 (1+1)

Theory

Principles of navigation –terms and definitions, types of navigation, method of position fixing, Nautical charts -types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions. Magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay points pelorus and azimuth mirror, method of observation. Sextant -parts and functions, finding adjustable and non- adjustable errors and principles and use. Hand lead line – construction and markings and method of taking soundings. Types of speed logs –patent log, impeller log, The IALA-buoy age systems, cardinal and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system, storm signals stations Indian coasts, Fog signals, types and methods. Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS
Principles of seamanship- Causes fire at sea, fire prevention on board the vessel and method of fire-fighting at sea and recommended fire- fighting appliances, Life- saving appliances – life jackets, life buoys and method of operations and contents, SART and EPIRB. Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law. Preparing vessel to face heavy weather. Temporary repairs for leaks constructions of steering system and rigging emergency jury rudder. Types of anchors and their applications. selection of suitable anchorage, procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust, transverse thrust mooring and securing the vessel to the jetty rigging fenders and gangways, and method of leaving vessels from the birth.

Practical

Practicing the different types of knots and wire splices, CHART WORK-Finding positions by latitudes and longitudes by position lines by cross bearing, horizontal sextant, angles, vertical sextant angle and by running fix, finding position by speed, distance and time findings set and drift of current and findings course made good speed made good and steering course and finding position by counter acting the current observation of RADAR. Anatomy of magnetic and Gyro compass and their errors calculation.

Reference Books

1. Cockcroft, A.N. 1997. *Seamanship and Nautical Knowledge*. Glasgow Brown Sons and Fercuson Ltd. England.
2. Joseph, T.K., Rewari, S.S.S. 2000. *Principles of Navigation*. Applied Research International, New Delhi.
1. Edward Coolin. 1987. *Nichols's Concise Guide to Navigation.* Volume 1 & 2. Glasgow Brown Sons and Fercuson Ltd. England.
2. Gregory P. Tsinker. 1997. *Handbook of Port and Harbour Engineering.* Champman and Hall, International Thompson Publishing.
3. Srinivasan, R .1989 **.***Harbour, Dock and Tunnel Engineering*. Charotar Pubalications Ltd. Anand.

Course: BFSC-409: Fishing Craft Technology 2(1+1)

Theory

Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance of fishing vessels. fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.

Practical

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

Reference Books

1. Jan-Olf-Traung. 1992. *Fishing Boats of the World*. Volume 1,2& 3. Food and

Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
2. John Fyson (ed.). 1985. *Design of Small Fishing Vessels*. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
3. Antony Hind, J. 1982. *Stability and Trim of Fishing Vessels*. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
4. Subramaniam, H. 1995. *Ship Stability*. Volumes 1, 2 & 3. Vijaya Publications Ltd. Mumbai.

Course: BFSC-410: Communications Skills and Personality Development 1 (0+1)

Practical

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. Organizing seminars and conferences.

Reference Books

1. Dahama, O.P. and O.P. Bhatnagar, 1980. Education and communication for development, Oxford & IBA Publishing College girls. New Delhi.
2. Everett Rogers, and Floyd Shoemaker, Communication of Innovation – a Cross Cultural Approach, New York Free Press.
3. Floyd, K., Guerrero, L.K. (2006), Nonverbal communication in close relationships, Mahwah, New Jersey: Lawrence Erlbaum Associates
4. Kamath, M.G. and others (1961) Extension Education in communication Development, Directorate and Reporting skills p.165.
5. Leagens, J.P. 1961.Extension Education in Community Development. Directorate of Extension, Govt.of India.

Semester-V (Total- 23 Credit: 14+09)

Course: BFSC-501: Microbial and Parasitic Diseases of Fish and Shellfish 3 (2+1)

Theory

General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Vaccines, Immunostimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices. SPF and SPR stocks –development and application. Bio-security principles, Sanitary and phytosanitary Agreement, Disease control through environmental management. Importance of Biofilm, Biofloc, Periphyton in aquatic Health Management, Zoonotic diseases. Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, Rapid diagnostic methods.

Practical

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

Reference Books

1. Roberts, R.J. (Ed.). 1989. Fish Pathology. Bailliere Tindall, New York.
2. Bell, T.A. and Lightner, D.V. 1988. *A Handbook of Normal Penaeid Shrimp Histology*. World Aquaculture Society, Baton Rouge, Louisiana.
3. Ferguson, H. 1989. *Systematic Pathology of Fish*. Lowa State University Press, Lowa.
4. Lightner, D.V. 1996. *A handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp*. World Aquaculture Society, Baton Rouge, Louisiana.
5. Takash Hibiya. 1982. *An Atlas of Fish Histology*: *Normal and Pathological Features*. Kodansha Ltd., Tokyo.

Course: BFSC-502: Fish Toxicology 2 (1+1)

Theory

General Toxicology: Definitions, Branches of Toxicology, Historical developments, Classification of poison. Types of poisoning- Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetics, Toxicodynamics, General approaches to diagnosis and treatment of poisoning.

Systemic Toxicology: Toxicity caused by metal and non-metals, Phytotoxins- Toxic principles of various alkaloids and toxic plants, Drug toxicity and toxicity caused by agrochemicals. Mycotoxins, Bacterial toxins. Collections and dispatch of specimens in Toxicological cases, Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish- Metabolism of toxic substances by aquatic organisms.

Practical

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe_3^+), Copper (Cu), Ammonia (ammonium ions) NH_4^+ Chloride (Cl^-), Phosphate ($P0_4$) Sulphate ($S0_4$) Flouride (Fl^-), Qualitative detection of Nitrite and Nitrate, Detection of hydrocyanic acid, Detection and Estimation of Mycotoxins, Test for detection of alkaloids, Estimation of LD_{5O} and ED_{5O} - Demonstration of drug toxicity.

Reference Books

1. Richard, T. Digiulio, David, E. Hinton. 2008. *The Toxicology of fish*. CRC Press, London, New York.
2. Maduri Sharma and Govind Pandey. 2014. *Toxicity and Treatment in Fish*. Narendra Publishing House, New Delhi.
3. Alan, G. Heath. 1995. Water pollution & Fish physiology: 2nd edition. Lewis publishers, Bocaraton, New York, London, Tokyo.

4. Aravind Kumar. 2008. *Aquatic Environment and Toxicology*. Daya Publishing House, New Delhi.
5. APHA. 2012. *Standard Methods for the Examination of Water and Waste water*: 22nd edition.

Course: BFSC-503: Coastal Zone Management and Disaster Management 3 (2+1)

Theory

Estuaries, Wetlands and Lagoons, Living resources – Non living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification. Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries. Problems related to sectors such as tourism and fisheries in the ICZM context. Environmental Impact Assessment (EIA): Principles, process and evaluation methods. Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters. Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. 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. Fire-fighting devices. Life saving appliances and first-aid.

Practical

Field visit to different coastal environments to study erosion of beaches, Identification of ecologically sensitive areas and protection, Study of CRZ, ICZM along the coastal belt, Study on implementation and violation of CRZ, Study of application of remote sensing and GIS, Project preparation of EIA. Methods for assessment of initial and long term damages. Preparedness in pre, during and post disasters. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Operation and usage of communication of channels and media. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counselling. Field visits and case studies. Group discussion.

Reference Books

1. Brahtz JFP. 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.
3. Clark JR. 1992. *Integrated Management of Coastal Zones*. FAO Fisheries Tech. Paper No. 327, Rome.
4. *Coastal Area Management and Development* 1982. UN Department of International Economic & Social Affairs, New York.

Course: BFSC-504: Coastal Aquaculture and Mariculture 3(2+1)

Theory

An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, Seed resources. Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of Shellfish Culture rafts, racks, cages, poles and ropes., Water and soil quality management. Estimation of growth, survival and pond productivity. Seaweed culture, Pearl culture, Sea ranching.

Practical

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

Reference Books

1. Bardach. 1972. Aquaculture, John Wiley and sons, New York.
2. Santhanam, R., Ranganathan, N. and Jagathesan, G. Coastal Aquaculture in India. CBS Publisher & Distributors, New Delhi.
3. Dash, M.L and Patnaik. P.N. 1994. Brackish Water Prawn Culture, Palani Paramount Publications, Palani.
4. Oven, O.H. 1981. Aquaculture of Grey Mullets, Cambridge University Press, Cambridge.
5 . Thomos, P.C. 1998. Shrimp Seed Production and Farming, Casino Publications, New Delhi.
6. James P.SB.R. 1991. Manual on pearl culture techniques, C.M.F.R.I. bulletin no 39. Cochin.
7. Mc Vey. J.P. et al. 1993. CRC Hand Book of Mariculture. Vol.2. Crustacean Aquaculture. CRC Press. Boca Raton .USA

Course: BFSC-505: Aquatic Mammals, reptiles and amphibians 1 (1+0)

Theory

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

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

Reference book

1. . Daniel, J. C) 2002.The Book of Indian Reptiles and Amphibians (Bombay Natural History Society.
2. Catriona, C. 2009.Reptiles (Usborne Beginners: Level 2)

Course: BFSC-506: Marine Fisheries 3 (2+1)

Theory

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic - demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of the India's EEZ. GIS and Remote sensing in marine capture fishery.

Practical

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

Reference Books

1. Bal, D.V. and Rao, V.K. 1990. *Marine Fisheries of India*. Tata Magraw Hill, New Delhi.
2. Jhingran, V.G. 1991. *Fish and Fisheries of India*. Hindustan Publishing Corporation, New Delhi.
3. Dixitulu, J.V.H. (Ed.) 1994. *Hand Book on Fisheries*. Global Fishing Chimes Pvt. Ltd., Visakhapatnam.
4. Iversen, E.S. 1996. *Living Marine Resources*. John Wiley & Sons, Inc., New York
5. Khan, I. 1999. *Marine Fishery Resources*. Rajat Publications, New Delhi.

Course: BFSC-507: Fish Packaging Technology 2 (1+1)

Theory

Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use in protective packaging with special reference to food. Printing for packaging and print identification. Closures of packaging, heat seals bottle closure. Principles of packaging fresh produce handling and transportation. Packaging for retail sale and storage. Packaging equipment and machinery. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. Laminations and co-extrusions. Retort pouch packaging - advantages and disadvantages. Biodegradable films, vacuum packaging, active packaging, MAP, Polymeric Packaging. Packaging requirements of fresh fish, Frozen fish, Canned Fish.

Transport worthiness of packaging materials, accelerated shelf testing. Materials and their safe use in food contact application. Safety and legislation aspects of packing. Labeling and bar coding.

Practical

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

Reference books

1. Gopakumar.K, 1993. *Fish Packaging Technology –Materials & Methods*. Concept Publishing Co., New Delhi.
2. Jeya Shakila, R., Sukumar, D. and Velayutham, P. 2007. *Packaging of Fish and Fishery Products*. TANUVASU, Tamil Nadu.
3. Ninawe, A.S. and RatnaKumar, K. 2008. *Fish Processing Technology and Product Development*. Narendra Publishing House, Delhi.
1. Wheaton, F. W. and T. B. Lawson,. 1985. *Processing Aquatic Food Products*, A Wiely – Inter Science Publication. U.S.A.

Course: BFSC-508: Fish By-Products and Waste Utilization 2 (1+1)

Theory

Fish meal. Dry reduction and wet reduction methods – specification – packaging and storage. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application. Shrimp wastes – chitin – chitosan-production – uses. Fish Protein Concentrate. Fish hydrolysate, partially hydrolysed and deodorized fish meat, functional fish protein concentrate and the incorporation to various products. Fish silage – acid silage – fermented silage – application. Fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

Practical

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

Reference Books

1. Brody.J. *Fishery By-products Technology*. AVI Publishing Company.
2. Velayutham, P. and Indira Jasmine, G. 1996. *Manual on Fishery By-Products*, Tamilnadu Veterinary and Animal Sciences University, Chennai.
3. Gopakumar, K. 1997. *Tropical Fishery Products.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

4. Shahidi,F and.J.R. Botta, 1994. *Seafoods chemistry*, Processing Technology and Quality. Blakie Academic and Professional, U.K.

Course: BFSC-509: Fishing Gear Technology 2(1+1)

Theory

Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG). Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test. Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines. Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system: British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing; advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond; square hexagonal and their measurement. Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velocity, weather resistance, melting point and visibility. Chemical and Biological properties. Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation. Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board.

Practical

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

Reference Book

1. Fridman, A.L. 1992. *Calculations for Fishing Gear Designs.* Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
2. Gabriel, O., Lange, K., Dahm, E., and Wendt, T. 2005. Von Brandt's *Fish Catching Methods of the World*, Blackwell publishing, Oxford, U.K., pp 523.

3. Gerhard Klust. 1982. *Netting Material for Fishing Gears*. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd , England.
4. F.A.O. 1978. *Catalogue of Fishing Gear Design.* Food and Agriculture Organization of the United Nations, Published by Fishing News Books Ltd, England.

Course: BFSC-510: Fishing Technology 2(1+1)

Theory

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements. Otter door: Different types of otter doors. Behaviour of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out- rig trawling bull trawling and mid water trawling. Constructional details of single boat purse seine; two boat purse seine and method of operation. Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom, mid water and pelagic gillnetting. Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole & line and trolling line. Operation of long line: set and drift long lining: bottom, mid water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch reducing devices. Deck equipment – types of winches, net haulers, line haulers, triple drum, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

Practical

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook & line. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

Reference Books

1. Jan-Olf-Traung. 1992. *Fishing Boats of the World*. Volume 1,2& 3. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
2. John Fyson (ed.). 1985. *Design of Small Fishing Vessels*. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
1. Antony Hind, J. 1982. *Stability and Trim of Fishing Vessels*. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
2. Subramaniam, H. 1995. *Ship Stability*. Volumes 1, 2 & 3. Vijaya Publications Ltd. Mumbai.

Semester-VI (Total- 22 Credit: 14+08)

Course: BFSC-601: Aquatic Pollution 2 (1+1)

Theory

Introduction to aquatic pollution: the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment. Classification of pollution: physical, chemical and biological classification of water pollution - description of terminologies. Sewage and domestic wastes: composition and pollution effects, sewage treatment and its reuse. Agricultural wastes: organic detritus, nutrients, Adverse effects of oxygen demanding wastes, importance of dissolved oxygen; Oxygen demand (BOD and COD); oxygen budget; biological effects of organic matter, eutrophication; red tides and fish kills. Pesticide types and categories: inorganic pesticides, organo-chlorine compounds, organo-phosphorous compounds, polychlorinated biphenyls (PCBs). Bioaccumulation and its impact on aquatic fauna and human health; toxicology. Heavy metals: sources and impacts on water qualities and aquatic organisms. Bioremediation and phytoremediation of pollution. Oil pollution: sources, impacts, and treatment of oil spills at sea; Beach cleaning. Microbial pollution: Types of aquatic microbes and their effects. Zoonosis and zoonotic diseases and its control. Development of antibiotic resistance and its impact; Biofilms and Biocorrosion; Radioactive pollution: sources and its impacts on the water quality organisms. Thermal pollution and its effects. Physical and chemical nature of effluents discharges from major industries in India. Monitoring and control of pollution: Biological indicators of pollution, solid waste management.

Practical

Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphide, phosphates, ammonia, nitrites, heavy metals in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Bacteriological tests of waste water: Coliform tests, IMVIC test, standard plate count. Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study.

Reference Books

1. Chhatwal, G.R., M.C. Mehra, T. Katyal, M. Satake, Mohan, K. and T. Nagahiro. 1995.*Environmental Water Pollution and its Control.* Anmol Publications Pvt. Ltd., NewDelhi.
2. Edward A. Laws. 1993. *Aquatic Pollution*. Second Edition. Wiley Interscience, JohnWiley & Sons Inc., New York.
3. APHA. 1995. *Standard Methods for the Examination of Water and Wastewater.* 19th Edition, American Public Health Association, Washington.
4. Clark, R.B. 1994. *Marine Pollution.* Clarendon Press, Oxford.
5. Hynes, H.B.N. 1978.*The Biology of Polluted Waters.* Liverpool University Press, UK.
6. Subba Rao, M.V. 1998. *A Manual of Practical Methods in Environmental Science.* Andhra University, Visakhapatnam.

Course: BFSC-602: Introduction to Biotechnology & Bioinformatics 2(1+1)

Theory

Biotechnology**:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes;

Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting.
Bioinformatics**:** Introduction to Bioinformatics; Biological Databases and tools : Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

Practical
Study of structure of Prokaryot and Eukaryot Cells. Study on Model of protein Synthesis, Study of models rDNA Technology, Cell Culture, Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNA sequence analysis and comparison.

Reference Books
1. Purdom, Colise. 1993. *Genetics and Fish Breeding*. Chapman and Hall, London.
2. Greg Lutz, C. 2001. *Practical genetics for Aquaculture*. Fishing News Books, London.
3. Larka, W.S. 2000. *Fish Genetics and Biotechnology*. CIFE. ICAR. Mumbai.
4. Sinnot, E.W., Dunn, L.C. and Dobzhansky, T. 1992. *Principles of Genetics*, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Tave, D. 1995. *Selective breeding Programmes for Medium Sized Fish Farms*. FAO Fisheries Technical Papers No. 352, Rome, FAO, 122 P.
6. Pandian, T.J., Strussmann C.A. and Marian, M.P. 2005. *Fish genetics and Aquaculture Biotechnology*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Course: BFSC-603: Fish Population Dynamics and Stock Assessment 3 (2+1)

Theory
The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Cario simulation model and ECOPATH model. Estimation of total fishing and natural mortality. 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. 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. Analytical models of fish stocks.

Practical
Study of length – weight relationship, 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.

Reference Books

1. Gulland, J.A. 1989. *Fish Stock Assessment*. John Wiley & Sons Inc., New York.
2. Hilborn, R. and Walters, J.W. 1992. *Quantitative Fisheries Stock Assessment*. Chapman & Hall Press, London.
3. Kuderskii, L.A. 1995. *Population Dynamics of Commercial fish in Inland Reservoirs*. Oxonian Press Pvt. Ltd., New Delhi.
4. Sakgawa, T.G. (Ed.) 1995. *Assessment Methodologies and Management*. Oxford & IBH Publishing Pvt. Ltd., New Delhi.

Course: BFSC-604: Fish Products and Value Addition 3 (2+1)

Theory

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–wetsalting and drysalting. 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 saltcured fish. Quality standard for salted and dry fish. Fish preservation by smoking-chemical composition of woods smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and method store move them. Hurdle technology in fish preservation and processing. Marinaded and fermented fish products–role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Fermented fish products of Southeast Asia. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscles tructure, myofibrillar protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products.Valueaddition. Diversified fish products: battered and braided products– fish finger, fish cutlet, fish wafer and fish soup powder etc. Andimitation products. HACCP in safe products production.

Practical

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn &fish pickles. Preparation of fermented fish sauce and marinaded products. Preparation of surimi and surimi based products. Preparation of diversified and value added fish products. Quality assessment of market sample of dried and fermented fish products.

Reference Books

1. Taneko Suzuki. 1981. *Fish & Krill Protein*: *Processing Technology.* Applied Science Publishers Ltd., London.
2. Ruiter. 1995. *Fish and Fishery Products*. CAB International Publication.
3. Winton & Winton. 1999. *Fish and Fish Products*. Allied Scientific Publishers.
4. Sen, D.P. 2005. *Advantages in Fish Processing Technology*. Allied publishers Pvt. Ltd. Mumbai.

Course: BFSC-605: Microbiology of Fish and Fishery Products 3 (2+1)

Theory

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food.Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi processed and processed fish and fishery products. Indicators of microbiological quality of fish and fishery products. Food borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention. Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

Practical

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

Reference Books

1. Pelczar, Michael J. 1993. *Microbiology*. Tata McGraw-Hill publishing Company Ltd., New Delhi.
2. Volk, A.W. and Wheeler, M.F. 1980. *Basic Microbiology*. J.B. Lippincott Company, London.
3. Buchanan, R.E. and Gibbons, N.E. (Co-Eds.). 1975. *Bergey's Manual of Determinative bacteriology*. The Williams & Wilkins Company, Baltimore.
4.Connell, J.J. 1980. *Control of Fish Quality*. Springer – Verlag, NewYork.
2. Huss, H.H., et al.1992. *Quality Assurance in the Fish Industry.* Elsever Science Publishers, B.V., Amsterdam, Netherlands.
5. *Quality Assurance in sea food Processing*. 2005. Published by CIFT, Cochin.
6. Burgess, et al. 1982. *Fish Inspection and Quality Control*. Fishing News Books Ltd England.
7. Bonell, A.O. 1994. *Quality Assurance in Seafood Processing*: A practical Guide. Chapman and Hall, New York.
8. Huss, H.H. 1994. *Assurance of Seafood Quality*. FAO Fisheries Technical Paper 334, FAO, Rome, Italy.

Course: BFSC-606: Fisheries Economics 3 (2+1)

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource,

scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost. Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving Forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

Practical

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

Reference Books

1. Jayaraman, R. 1996. *Fisheries Economics*. Tamilnadu Veterinary and Animal Science University, Tuticorn.
2. Rao, N. Subba. 1986. *Economics of Fisheries.* Daya Publishing House, Delhi.
3. Dewett, K.K. and Varma, J.D. 1993. *Elementary Economic Theory.* S.Chand, New Delhi.
4. Korakandy, R. 1996. *Economics of Fisheries Management*. Daya Publishing House, Delhi.
5. Singh, R.K.P. 2003. *Economics of Aquaculture*. Daya Publishimg House, New Delhi.

Course: BFSC-607: Fisheries Co-operatives and Marketing 2 (1+1)

Theory

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account.

Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment,

marketing strategies, product development and product mix, consumer behavior and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification- export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector.

Practical

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

Reference Books

1. Chaston, I. 1987. *Marketing in Fisheries and Aquaculture*. Fishing News Books, England.
2. Sathaidhas, R. 1997. *Production & Marketing Management of Marine Fisheries in India.* Daya Publishing House, Delhi.
3. Kotler, Philip. 1995. *Principles of Marketing*. Prentice-Hall of India, New Delhi.

Course: BFSC-608: Fisheries Extension Education 2 (1+1)

Theory

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; 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, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis; case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

Reference Books

1. Pandey, S.K. 1997.*Teaching Communication.* Common Wealth Publishers, New Delhi.
2. Adivi Reddy, A. 1987. *Extension Education.* Sree Lakshmi Press, Bapatla, A.P.
3. Bhatia and Bhatia. 1992. *A Text Book of Educational Psychology.* Boaba House, Delhi.
4. Chitambar, J. B. 1990. *Introductory Rural Sociology.* Wiley Eastern Ltd., New Delhi.
5. Supe, S.V. 1997. *An Introduction to Extension Education.* Second Edition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Course: BFSC-609: Fisheries Policy and Law 1 (1+0)

Theory

Introduction to public administration, principles of organization and management of publicenterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Present relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of department of fisheries, corporations and cooperatives. Different central and state level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community based resource management plans. Historical review of fisheries development and management in India and world. International agencies / organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries. Laws relating to conservation and management of fishery resources in marine and inland sectors. Recent changes in land reforms. Land reforms legislation as applicable to aquaculture. Judicial judgments relating to Aquaculture. Objectives, functions and authority of fishery regulatory agencies like Coastal Regulatory Zone (CRZ) and Aquaculture Authority of India. Brackish water aquaculture act, Marine fisheries policy, Laws relating to fish products and marketing. International Law of the Seas and international commissions on fisheries and their impact.

Reference Books

1. Ayyappan, S., Jena, S.K., Gopalakrishna, A. and Pandey, A.K. 2006. *Handbook on Fisheries and Aquaculture*, Indian Council of Agricultural Research, New Delhi.
2. Brig.(Dr) B.Khanna, 2005. All you wanted to know about Disasters, New India Publishing Agency, New Delhi.
3. Dixitulu, J.V. and Paparao, G. 1994. *Handbook on Fisheries*, Global Fishing Chimes Private Ltd, Visakapatnam.
4. Giriappa, S. 1994. *Role of Fisheries in Rural Development.* Daya Publishing House, New Delhi.

Course: BFSC-610: Fisheries Business Management and Entrepreneurship Development 1(1+0)

Theory

Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; Generation, incubation and commercialization of ideas and innovations.

Government schemes and incentives for promotion of entrepreneurship. Preparation of enterprise budget for integrated fish farming. Fiscal and monitory policies and its impact on entrepreneurship. Infrastructural and other financial requirement for fishery entrepreneurship Government policy on Small and Medium Enterprises (SMEs) / SSIs. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of fisheries inputs industry. Characteristics of Indian fisheries processing and export industry. Introduction to fish business management- Concept of management, management process (planning, organising, staffing, leading and controlling), Organizational behaviour, human resource planning, new dimensions in fish business environment and policies. Accounting procedures of fish business entity. Emerging trends in fish production, processing, marketing and exports. Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs. Globalisation and the emerging business /entrepreneurial environment. Social Responsibility of Business.

Reference Books

1. Agarwal, S.C. 1990. *Fishery Management*. Ashish Publishing House, New Delhi.
2. Subbareddy, S. and Raghuram, P. 1996. *Agricultural Finance and Management.* Oxford & IBH Publishing, New Delhi.
3. Korakandy, R. 1996. *Economics of Fisheries Management*. Daya Publishing House, Delhi.

Semester-VII (Total- 20 Credit: 0+20)

Student READY (Rural and Entrepreneurship Awareness Development Yojana)

Student READY Program will be taken up during VII and VIII semesters and will have the following components. To reorient fisheries graduates for ensuring and assuring employability and develop entrepreneurs for emerging knowledge intensive aquaculture, the component envisages the introduction of the program as an essential prerequisite for the award of degree to ensure hands on experience and practical training. It includes following components, which are interactive and are conceptualized for building skills in project development and execution, decision-making, individual and team coordination, approach to problem solving, accounting, quality control, marketing and resolving conflicts, etc. with end to end approach in Student READY program.

Course: BFSC-701: In-plant attachment (8 weeks) 10 (0+10)

In-plant attachment / training for duration of 8weeks in relevant industry to gain the knowledge and experience of the work culture. In Plant training by reputed organization either MNC's or organised sectors provide an industrial exposure to the students as well as to develop their career in the high tech industrial requirements. The students shall be sent to the aqua-farm, hatchery, ornamental fish culture unit, processing plants, product development unit or export agency as per the need.

Course: BFSC-702: Rural Fisheries Work Experience (8 weeks) 8 (0+8)

Rural Fisheries Work Experience also enable the students to gain rural experience giving them confidence and enhancing on farm problem solving abilities in real life situations especially in contact with farmers, growers etc. This is for the duration of 8 weeks

Course: BFSC-703: Study Tour (in and outside State) 2 (0+2)

Study tour to different research institutes / colleges / organisations of fisheries importance both inside the state and outside state shall be carried out with a specific learning goals so as to provide students with first-hand knowledge of many academic institutions. The duration for study tour is 4 weeks.

Semester-VIII (Total- 29 Credit: (06+23)

Course: BFSC-801: Refrigeration and Equipment Engineering 3 (2+1)

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work-A path function. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, Application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy. Refrigeration: History of refrigeration, Definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system. Refrigeration plant: Layout of refrigeration plant, Construction. Insulating materials used for the cold storage construction, Frozen product storage capacity of cold storage, usage of Ante-room. Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle. Compressors: Definition, Types of compressor, construction, working principle advantages and disadvantages. Evaporator: Definition, Types of Evaporator, construction, working principle advantages and disadvantages. Condenser: Definition, Types of Condenser, Cooling Towers, construction, working principle, advantages and disadvantages. Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Ice-plant: Ice plant planning Brine tank construction, preparation of brine, Types of ice, Storing of ice, Equipments used in ice plants. Freezers: Definition, Design and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated sea water (RSW), Chilled sea water (CSW). Refrigerated transport. Cooling load: Unit of refrigeration, coefficient of performance (C.O.P), Refrigeration effect, study and use of Psychometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipments. Theory of machines: Transmission of power, friction wheels, shaft, gears, belt and Chain drive. Study of equipments used in fish processing with particular

reference to canning, sausage, freeze drying and irradiation. Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

Practical

Graphically represented symbols used in refrigeration, Drawing of Refrigeration cycle and Fish processing machineries plant layout Handling and operational drawings of compressors, condensers, evaporators expansion valves. Study of auxiliary equipments: Power transmission line diagram of different fish processing machineries. Visit to processing plant refrigeration plant, Visit to ice plant, Visit to fishing harbor or landing centers to study the fish hold, refrigerated fish rooms.

Reference Books

1. Arora, S. Domkundwar. 1989. *Refrigeration and Air Conditioning.* Dhanpatrai & Sons, Delhi.
2. Cowly, J. 1993. *The Running and Maintenance of Marine Machinery*. Published by Marine Management Ltd for the Institute of Marine Engineers.
3. Dag Pike. 1992. *Fishing Boats and their Equipment*. Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.
4. Kondrashova, N.G. 1984. *Shipboard Refrigeration and Fish Processing Equipment.* Amerind Publishing Co Private Ltd. New Delhi.
5. Meritt, J.H. 1989. *Refrigeration on Fishing Vessel.* Food and Agriculture Organization of the United Nations. Published by Fishing News Books Ltd, England.

Course: BFSC-802: Fish Pharmacology 3 (2+1)

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs. Pharmacolotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and Excretion of drugs. Factors influencing drug metabolism. Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non receptor mediated action. Dose Response Relationship, half life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system, nervous system and cardiovascular system. Drugs used in fish transportation. Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry.

Practical

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

Reference Books

1. Treves Brown,K.M. 2008. *Applied Fish Pharmacology*. Springer International edition,

New Delhi.
2. Satoskar, R.S., Bhandarkar, S.D. and Ainapure, S.S. 2001. *Pharmacology and pharmacotherapeutics*. Popular Prakashan, Mumbai.
3. Sharma, H.L. and Sharma, K.K. 2012 *Principles of pharmacology*: 2nd edition. Para Medical publishers, New Delhi.
4. Tripathi, K.D. 2013. *Essentials of medical pharmacology*: 7th edition. Jaypee brothers medical publishers pvt.ltd, New Delhi, Philadelphia, London.
5. Se-Kwonkinj. 2013. *Marine Pharmacognosy, Trends and Applications*. CRC Press publishers, London, Newyork.

Course: BFSC-803: Quality Assurance of Fish and Fishery Products 3 (2+1)

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Pre-harvest and post harvest factors affecting quality. Assessment of quality changes in fresh and iced fish. Quality changes during processing. Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. Food laws and standards, national and international legislation, mandatory and non mandatory standards. Role of export inspection council & export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products, Legislation for export quality assurance in India.Certification system for fish & fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish & fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues. GOI notifications on fish and fishery products. General requirements for export of fish and fishery products to the EU. International regulatory framework for fish safety and quality. Prerequisites to HACCP, Labelling for product traceability and Labelling requirements- National and international, legislation on labelling, components of traceability code-nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people. EU legislation on traceability of fish and fish products, Assessment of food safety programmes, The HACCP for seafood industries and protection of food from adulterants. Standards for sea foods.FSSA, FDA, ISO.Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability. Waste management in seafood processing.

Practical

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

Reference books

1. Connell, J.J. 1980. *Control of Fish Quality*. Springer – Verlag, NewYork.
2. Huss, H.H., et al.1992. *Quality Assurance in the Fish Industry.* Elsever Science

Publishers, B.V., Amsterdam, Netherlands.
3. Jeyasekharan, G., Jaya Shakila, R. and Sukumar, D. 2006. *Quality and Safety of Seafoods* – Text Book, Tamilnadu Veterinary and Animal Sciences University, Chennai.
4. Quality Assurance in Sea Food Processing. 2005. Published by CIFT, Cochin.
5. Burgess, et al. 1982. *Fish Inspection and Quality Control*. Fishing News Books Ltd England.
6. Bonell, A.O. 1994. *Quality Assurance in Seafood Processing*: A practical Guide. Chapman and Hall, New York.
7. Huss, H.H. 1994. *Assurance of Seafood Quality.* FAO Fisheries Technical Paper 334, FAO, Rome, Italy.
8. Guthrie, R.K. 1988. *Food Sanitation.* Van Nostrand Reinhold, New York.

Student READY Programme (20 Credit)

Student READY Experiential Module (concurrent with the semester)

This will include capacity building and skill development of the students in planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency with a total credit load of 0+20 credit hours as detailed below:

Course: BFSC-804: Skill Development 5 (0+5)

Skill development component include use of Aquaculture Systems & devices for enhancing functional skill. It is expected that basic infrastructure and Experiential Learning Unit available university may help in boosting livelihood ensuring opportunity. Skill Development includes Aquarium fabrication, Analysis of soil and water quality parameters, Preparation of Fish products or in any appropriate applied aspect of fisheries. Suggested duration is for 1 week.

Course: BFSC-805: Experiential Learning Programme 12 (0+12)

Experiential Learning helps the student to develop competence, capability, capacity building, acquiring skills, expertise, and confidence to start their own enterprise and turn job creators instead of job seekers. This is step forward for earning while learning concept. Experiential Learning is major step forward for High Quality Professional Competence, Practical Work Experience in Real Life Situation to Graduates, Production Oriented Courses, Production to Consumption Project working, Facilitates producing Job Providers rather than Job Seekers and Entrepreneurial Orientation. For Experiential Learning Program will have 0+12 credit hours a minimum of two out of the following areas:

I. Aqua farming
II. Post-Harvest Technology
III. Ornamental fish culture
IV. Seed Production
V. Aqua-clinic
VI. Trade and export management

Course: BFSC-806: Project work 2 (0+2)

Student Project is essential for students interested in higher education. Through this component, they will know how to identify research problem, experimental set up and writing report etc. Student will select relevant or interested area of specialization such as Fish pathology, Fish diagnosis, Fish pharmacology, Fish Toxicology, Fish nutrition, Fish immunology, Fish genetics and breeding, Ornamental fish production, Genomics in Aquaculture, Fish stock assessment, Aquatic pollution, Fish value addition, Fish in nutrition, Fish processing and waste management, Quality control and quality assurance, Fish products and by-products etc. He/she will prepare a research project plan and it will be presented in-front of Team of Examiners recommended by BOS. Also, for each student, one Mentor/Advisor will be provided, who will guide the student in completion of proposed research plan. This exercise will prepare students interested in higher education. They will be exposed with identifications of problems in experimental setup and project preparation.

Course: BFSC-807: Seminar 1 (0+1)

One credit is allotted for the seminar. Student shall deliver the seminar on his / her project work before the Team of Examiners recommended by BOS. The evaluation for the same will be conducted by the same committee as prescribed by the BOS of the University.

END