

**NEW
COURSE CURRICULA
FOR
BACHELOR OF FISHERIES SCIENCE
(B.F.Sc.)**

(FACULTY OF FISHERIES)

(As per ICAR Fourth Dean's Committee Recommendations)



**COLLEGE OF FISHERIES SCIENCE
NAVSARI AGRICULTURAL UNIVERSITY
NAVSARI-396 450 (GUJARAT)**

August-2015

RESTRUCTURING OF UNDER GRADUATE PROGRAMME FOR INCREASED PRACTICAL AND PRACTICE CONTENTS

In order to make higher agricultural education relevant to present day needs, produce graduates with entrepreneurial skills for self-employment and contributors of rural livelihood and food security need is felt for reorienting agricultural education. In view of globalization and development of new technologies, it is essential that the students meet international quality standards. One of the pillars for quality assurance in agricultural education is the curriculum, which takes care of contemporary needs, provides for analytical skill, entrepreneurship and experiential learning for having confidence to do profitable farming and contributors of sustainability of agriculture. With this objective the Committee decided on procedure for reorienting curriculum, the details of which have been given in introduction chapter.

Based on in-depth discussion at university and national level involving different stakeholders, new curriculum has been designed details of which are given in this chapter discipline wise. The main features include inclusion of new areas and increase in practical content through experiential learning duration of which is ranging from 6 months to a year. In all disciplines attachment with industry has been indicated. The details of courses department wise and semesterwise for each of the discipline along with change effected are given. Budgetary support for experiential learning and or professional courses has also been indicated.

In making recommendations, the Committee has taken note of the global developments in science and technology, the skills our graduate must possess to meet new challenges thrown open as a result of globalization and preparing farmers for new opportunities at national and international level. The Committee feels confident that with the implementation of new curriculum coupled with central assistance as recommended would make major change and our graduates would have stamp of international excellence in education.

FISHERIES SCIENCE

Introduction:

Indian Fisheries Sector has shown tremendous progress in last 50 years. Present fish production in the country is more than 6 million tonnes out of which more than 50% is contributed by inland fisheries sector. The fisheries sector has shown steady growth rate of more than 7% per annum. The major contributing factor for this accelerated growth in fisheries are availability of skilled human resource, development and dissemination of new technologies, high receptivity of fishermen and women and increased investment by the government. The technology development has been the result of sustained research efforts of the central and state fisheries institutions and some traditional universities. There are eight national fisheries institutions in the country under ICAR serving various specialized areas viz. CMFRI, Kochi for marine fisheries resources; CIFT, Kochi for harvest and post harvest technology; CIFRI, Barrackpore for inland fisheries resources; CIBA, Chennai for coastal aquaculture,; CIFA, Bhubaneshwar for freshwater aquaculture; NRC-CWF, Bhimtal for cold water fisheries resources; NBFGR, Lucknow for conservation of native fish germ plasm and CIFE, Mumbai for fisheries education and training.

Fisheries education in the country has progressed at a good pace over the years. Central Institute of Fisheries Education, Mumbai was established under the Government of India in the year 1961 and was brought under Indian Council of Agricultural Research in 1979. It got upgraded as a Deemed University in 1989 and is now offering MFSc and PhD programmes in various disciplines. The first fisheries college under the State Agricultural University was established at Mangalore in 1969. Now there are thirteen fisheries colleges spread across the country.

Mission:

To make available technically qualified fisheries professionals with sufficient skills to manage, conserve and develop diversified fisheries resources in the country to provide food security and quality animal protein.

Objectives:

- To create a cadre of fisheries professionals who are well qualified to meet demands of fisheries sector
- To develop entrepreneurial skills.
- To make students aware of national and international issues related to fisheries.

Present status:

No. of colleges and enrollment: Following Colleges of Fisheries are currently producing skilled human resources for fisheries sector:

Sr.	Name of Fisheries College	Year of Start	Intake capacity
1	College of Fisheries, Mangalore, Karnataka	1969	40
2	Fisheries College and Res. Inst., Thuthukkudi, Tamilnadu	1977	35
3	College of Fisheries, Panangad, Kerala	1979	50
4	College of Fisheries, Nellore, Andhra Pradesh	1981	30
5	College of Fisheries, Ratnagiri, Maharashtra	1981	40
6	College of Fisheries, Pantnagar, Uttaranchal	1985	20
7	College of Fisheries, Dholi, Bihar	1986	10
8	College of Fisheries, Raha, Assam	1988	20
9	College of Fisheries, Veraval, Gujarat	1991	30
10	College of Fisheries, Railagunda, Orissa	1992	32
11	College of Fisheries, Mohanpur, West Bengal	1995	-
12	College of Fisheries, CAU, Agartala, Tripura	1998	22
13	College of Fisheries, MPUAT, Udaipur	2002	10

RAWE Programme:

All colleges have adopted RAWE in semester-VIII. It varies from 105-120 days. It is conducted in Colleges, Central Institutions, Private farms, Feed mills, State Govt. farms. It is done in areas-processing, aquaculture, extension in most of the colleges. In AP RAWE is divided - Farming-5 weeks; Hatchery-4 weeks; Processing- 5 weeks; Feed Plants-1 week; Sea- 1 week; Catch assessment- 2 weeks; Fishery Environment- 1 week; Extension & Economics-2 weeks. RAWE evaluation is done by a. Daily work diary b. Report c. Written test d. Viva voce d. Assignments and seminars.

Examination pattern:

In most of the colleges 80-85% is external and 15-20% internal.

Changes Effectuated in Course Curriculum and Syllabus:

- Revised B.F.Sc. program will have 6 semesters of course work; seventh semester Hands-on-Training program in the area specified with a credit load of 20 credits and eighth semester industry attachment.
- New courses added are Ornamental fish production and management; Biotechnology & Bioinformatics; Genetics & Breeding; Ecology & Biodiversity; Coastal Zone Management; Disaster Management in Fisheries; Entrepreneurship Development; Biochemical Techniques & Instrumentation; Information & Communication Technology.
- Several courses revised/merged to accommodate all course work in 6 semesters so that semesters VII and VIII can be used for skill development and industry attachment. Anatomy of fin fish and shell fish combined so also Biology of fin fish and shell fish and Physiology of fin fish and shell fish. Languages, computer courses, NSS, physical education are recommended as non-credit courses and compulsory for all. Canning technology and Packaging technology are merged as one course. Genetics and biotechnology split up as Genetics and Breeding and Biotechnology & Informatics separately.
- The theory to practical ratio now will be 3:4 approximately.
- The students will have more practical exposure and while working in last two semesters their professional skill and confidence level will be much higher which will help them to start their own enterprise.

NAVSARI AGRICULTURAL UNIVERSITY

COURSE CURRICULUM FOR B.F.Sc.

DISTRIBUTION OF COURSE CREDITS

A. Discipline-wise

Sr.No.	Discipline	Course credits(Nos.)	Weightage (%)
1.	Basic Sciences, Humanities and Related Courses	32+3*	19.23
2.	Fisheries Resource Management	24	13.19
3.	Aquaculture	32	17.58
4.	Harvest and Post-Harvest Technology	26	14.28
5.	Aquatic Environment	20	10.99
6.	Fisheries Work Experience	20	10.99
7.	Hands-on Training” (Experiential Learning)	25	13.74
		179+3*	100.00

* Non credit course

B. Semester-wise

Semester	Credits	Semester	Credits
I	21+2*	V	23
II	25+1*	VI	22
III	22	VII	25
IV	21	VIII	20

DISTRIBUTION OF COURSES

No	Sr. No	Code	Discipline-wise Courses	Credit	
I	Aquaculture			19+13	32
	1	FAQ101	Principles of Aquaculture	1+1	2
	2	FAQ102	Freshwater Aquaculture	2+1	3
	3	FAQ201	Fish Nutrition and Feed Technology	2+1	3
	4	FAQ203	Culture of Fish Food Organisms	1+1	2
	5	FAQ202	Aquaculture Engineering	2+1	3
	6	FAQ204	Ornamental Fish Production and Management	1+1	2
	7	FAQ206	Coastal Aquaculture and Mariculture	2+1	3
	8	FAQ301	Finfish Breeding and Hatchery Management	2+1	3
	9	FAQ303	Shellfish Breeding and Hatchery Management	2+1	3
	10	FAQ305	Diseases and Management	2+2	4
	11	FAQ302	Fish Biotechnology & Bioinformatics	1+1	2
	12	FAQ304	Fish Genetics and Breeding	1+1	2
II	Fisheries Resource Management			14+10	24
	1	FRM101	Taxonomy of Finfish	1+2	3
	2	FRM102	Taxonomy of Shellfish	1+2	3
	3	FRM103	Anatomy of Finfish and Shellfish	2+1	3
	4	FRM104	Biology of Finfish and Shellfish	2+1	3
	5	FRM201	Inland Fisheries	2+1	3
	6	FRM202	Physiology of Finfish and Shellfish	2+1	3
	7	FRM301	Marine Fisheries	2+1	3
	8	FRM302	Fish Population Dynamics and Stock Assessment	2+1	3
III	Aquatic Environment			12+8	20
	1	AEN101	Meteorology and Geography	1+1	2
	2	AEN102	Soil and Water Chemistry	1+2	3
	3	AEN104	Limnology	2+1	3
	4	AEN202	Oceanography	2+1	3
	5	AEN201	Marine Biology	2+1	3
	6	AEN301	Ecology and Biodiversity	2+1	3
	7	AEN302	Pollution and Coastal Zone Management	2+1	3

No	Sr. No	Code	Discipline-wise Courses	Credit	
IV	Harvest and Post-Harvest Technology			15+11	26
	1	PHT102	Food Chemistry and Fish in Nutrition	2+1	3
	2	PHT201	Refrigeration and Equipment Engineering	1+1	2
	3	PHT203	Freezing Technology	2+1	3
	4	PHT202	Fishing Craft Technology	1+1	2
	5	PHT204	Canning and Fish Packaging Technology	2+1	3
	6	PHT301	Navigation and Seamanship	1+1	2
	7	PHT303	Fishing and Gear Technology	2+1	3
	8	PHT302	Fish Products and Byproducts Technology	2+2	4
	9	PHT304	Fish Microbiology and Quality Assurance	2+2	4
V	Basic Sciences and Humanities			20+12	32
	1	BSH105	Information & Communication Technology	1+1	2
	2	BSH107	Statistical Methods	1+1	2
	3	BSH203	Economics	2+1	3
	4	BSH201	Extension Education	2+1	3
	5	BSH202	Fisheries Administration and Legislation	2+0	2
	6	BSH301	Disaster Management in Fisheries	1+1	2
	7	BSH302	Financing and Marketing Management	1+1	2
	8	BSH304	Entrepreneurship Development	1+1	2
	9	BSH101	Principles of Biochemistry	2+1	3
	10	BSH103	Fundamentals of Microbiology	2+2	4
	11	BSH102	Biochemical Techniques and Instrumentation	1+2	3
	12	PED101	*Physical Education / NSS / NCC	0+1	1
	13	PED102	*Physical Education / NSS / NCC	0+1	1
	14	ESC102	Environmental Studies	4+0	4
	15	ENG101	*Communication skills	1+0	1

* Non credit course

COURSE CURRICULUM FOR B.F.Sc.
Semester-wise Distribution of Course

Semester-I

No	Course title	Discipline	Credit hours	Total Credits
1.	Principles of Aquaculture	FAQ 101	1+1	2
2.	Taxonomy of Finfish	FRM 101	1+2	3
3.	Anatomy of Finfish and Shellfish	FRM 103	2+1	3
4.	Meteorology and Geography	AEN 101	1+1	2
5.	Principles of Biochemistry	BSH 101	2+1	3
6.	Fundamentals of Microbiology	BSH 103	2+2	4
7.	Information & Communication Technology	BSH 105	1+1	2
8.	Statistical Methods	BSH 107	1+1	2
9.	*Physical Education./ NSS / NCC	PED101	0+1	1
10.	*Communication skills	ENG101	1+0	1
Total			: 11+10 = 21	

Semester-II

1.	Freshwater Aquaculture	FAQ 102	2+1	3
2	Taxonomy of Shellfish	FRM 102	1+2	3
3.	Biology of Finfish and Shellfish	FRM 104	2+1	3
4	Soil and Water Chemistry	AEN 102	1+2	3
5.	Limnology	AEN 104	2+1	3
6.	Food chemistry and Fish in Nutrition	PHT 102	2+1	3
7.	Biochemical Techniques and Instrumentation	BSH 102	1+2	3
8.	Environmental Studies	ESC102	4+0	4
9.	*Physical Education./ NSS / NCC	PED102	0+1	1
Total			: 15+10 = 25	

Semester-III

1.	Fish Nutrition and Feed Technology	FAQ 201	2+1	3
2.	Culture of Fish Food Organisms	FAQ 203	1+1	2
3.	Inland Fisheries	FRM 201	2+1	3
4.	Marine Biology	AEN 201	2+1	3
5.	Refrigeration and equipment engineering	PHT 201	1+1	2
6.	Freezing technology	PHT 203	2+1	3
7.	Extension Education	BSH 201	2+1	3
8	Economics	BSH 203	2+1	3
Total			: 14+08 = 22	

* Non credit course

Semester-IV

No	Course title	Discipline	Credit hours	Total Credits
1.	Aquaculture Engineering	FAQ 202	2+1	3
2.	Ornamental Fish Production and Management	FAQ 204	1+1	2
3.	Coastal Aquaculture and Mari culture	FAQ 206	2+1	3
4.	Physiology of Finfish and shellfish	FRM 202	2+1	3
5.	Fishing Craft Technology	PHT 202	1+1	2
6.	Canning and Fish Packaging Technology	PHT 204	2+1	3
7.	Oceanography	AEN 202	2+1	3
8.	Fisheries Administration and Legislation	BSH 202	2+0	2

Total : 14+07 = 21

Semester-V

1.	Finfish Breeding and Hatchery Management	FAQ 301	2+1	3
2.	Shellfish Breeding and Hatchery Management	FAQ 303	2+1	3
3.	Diseases and Management	FAQ 305	2+2	4
4.	Marine Fisheries	FRM 301	2+1	3
5.	Ecology and Biodiversity	AEN 301	2+1	3
6.	Navigation and Seamanship	PHT 301	1+1	2
7.	Fishing and Gear Technology	PHT 303	2+1	3
8.	Disaster Management in Fisheries	BSH 301	1+1	2

Total : 14+09 = 23

Semester-VI

1.	Fish Biotechnology & Bioinformatics	FAQ 302	1+1	2
2.	Fish Genetics and Breeding	FAQ 304	1+1	2
3.	Fish Population Dynamics and Stock Assessment	FRM 302	2+1	3
4.	Pollution and Coastal Zone Management	AEN 302	2+1	3
5.	Fish Products and Byproducts Technology	PHT 302	2+2	4
6.	Fish Microbiology and Quality Assurance	PHT 304	2+2	4
7.	Financing and Marketing Management	BSH 302	1+1	2
8.	Entrepreneurship Development	BSH 304	1+1	2

Total : 12+10 = 22

Semester-VII

1.	*Hands-on Training” (Experiential Learning)	0+25	25
	(I) Post Harvest Technology		
	(II) Seed Production		

Total : 0+25 = 25

* The students will have to select any one module

Semester-VIII

1.	Fisheries work experience	0+20	20
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Total : 0+20 = 20

Grand Total 80+99 = 179+3* = 182

* Non credit course

COURSE OUTLINES

SEMESTER-I

FAQ 101 PRINCIPLES OF AQUACULTURE (1+1=2)

Theory

Basics of aquaculture-definition and scope. History of aquaculture: Present global and national scenario. Aquaculture vs agriculture. Overview of national and international agricultural systems. Systems of aquaculture - pond culture, pen culture, cage culture, running water culture, zero water exchange system, etc. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackishwater and inland saline ground water. Pre-stocking and post stocking pond management. 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 and estimation of productivity. Physical, chemical and biological factors affecting productivity of ponds. Nutrition, health management and economics.

Practical

Practices on pre-stocking and post stocking management. Analysis of water and soil samples. Collection, storage and analysis of livestock wastes and crop residues. Study of biogas slurry on water quality.

FRM 101 TAXONOMY OF FINFISH (1+2=3)

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. Important fishes of the world. Other important groups of aquatic vertebrates. Introduction to modern taxonomic tools: DNA polymorphism, protein analysis and chromosome morphology

Practical

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools:DNA polymorphism, protein analysis and chromosome morphology Visit to fish landing centres to identify the catch composition

FRM 103 ANATOMY OF FINFISH AND SHELLFISH (2+1=3)

Theory

Study of internal anatomy of important groups of shellfish and finfish. Study of oral region and associated structures in finfishes. Studies on Digestive system and Associated digestive glands. Circulatory system. Respiratory system. Nervous system. Urino-genital system. Endocrine system, Circulatory, Skeletal systems and Sensory organs.

Practical

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

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 measurements and instruments. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India and AP. 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 effecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; 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

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

Theory

Major biomolecules in foods and their important functions. Classification of carbohydrates. Structures, functions and properties of mono- di- and polysaccharides. Isomerism. Mutarotation. Seaweed polysaccharides – sources and uses. Glycolysis and TCA cycle. Classification structures, function and properties of amino acids. Amino acids and polypeptide. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Principles of protein purification. Protein biosynthesis. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Auto-oxidation, saponification value and iodine number. Peroxide value, thiobarbituric acid number, oxidative and hydrolytic rancidity. Principle of fatty acid analysis. Significance of Omega 3 and 6 fatty acids. Beta oxidation. Structure, function and importance of nucleic acids. Genetic code and recombinant DNA. Transcription; translation. Enzymes- nomenclature; classification; specificity; mechanism of enzyme action; Kinetics and regulation of enzyme activity, purification of enzymes. Steroid and peptide Hormones- Chemistry and function. Structure and functions of fat and water soluble vitamins.

Practical

Estimation of glucose and protein in fish tissues. Preparation of chemical solutions, buffers and reagents. Extraction and estimation of total lipids from fish tissue. Applications of paper chromatography, thin layer chromatography, ion exchange chromatography. Principles of electrophoresis. Estimation and separation of proteins by electrophoresis in fish tissues; Determination of saponification and iodine values. Determination of lipase activity in fish tissues. Gel filtration. Preparation of tissue homogenate and organelle isolation.

Theory

History of microbiology, microbial world and their structural characters. Prokaryotes – bacteria, actinomycetes, spirochaetes, cyanobacteria, mycoplasma, rickettsiae, archaeobacteria viruses, structure, classification, characters and their economic importance. Eukaryotes – fungi, algae, protozoan – structure, classification, characters and their economic importance. Microscopy, sterilization, staining, filtration, Disinfection. Microbial nutrition-nutritional requirements, cultivation of microorganisms, types of nutrition photoheterotrophs, chemoheterotrophs, photoautotrophs, chemoautotroph and their ecological significance. Microbial growth and metabolism – measurement of cell growth, dynamics of bacterial growth, factors affecting growth. Energy yielding reactions, respiration – aerobes, anaerobes, microaerophiles and facultative anaerobes. Enzymes – characters and their importance in microbial metabolism. Pathways of catabolism – EM, ED pathways and TCA cycle, fermentation, types of fermentation. Bacterial photosynthesis, Microbial ecology- microbial interactions, types of interaction, influence of physico-chemical factors like pH, temperature, moisture, light, osmotic pressure, organic and inorganic substances, relationship with soil, water, air, food etc. Microbial genetics; genotypic and phenotypic characters, mutation and its significance, genetic recombination, transformation, transduction and conjugation, genetic engineering and biotechnology. Pathogenicity and virulence. Sources of infection. Transmission of disease producing organisms. Portals of infection. Effect of pathogenic bacteria on the body. Symptoms and lesions. Virus, Symmetry of virus, RNA and DNA

virus, classification, cultivation of virus, replication of virus. Host virus interactions. Virus-virus interactions. Interference and interferon, control of viral infection. Immunology and serology – types of immunity, natural and acquired, cellular and humoral, antigen-antibody reactions and their significance, serological methods in disease diagnosis.

Aquatic microbial groups, Role of microorganisms in the cycling of elements in water, breakdown and production of organic matter; Carbon, nitrogen, sulfur, phosphorus iron and manganese cycles. Role of bacteria and fungi in sedimentations, microorganisms and water pollution; Effluent treatment; Bacteria of extreme environment, deep sea bacteria, hydrothermal bacteria, halophilic bacteria, their physiology and nutrition;

Practical

Introduction to microscopy; study of different types of microscopes; wet mount and hanging drop preparations; sterilization by different methods, filtration, dry heat, moist heat, chemical use etc. staining techniques – simple, differential, structural and microchemical techniques; distribution of micro-organisms in nature; isolation, pure culture and preservation methods; enumeration of micro-organisms, environmental influences on micro-organisms; biochemical tests; observation of fungi, blue-green algae, bacteria and protozoans. Study and enumeration of coliform, iron, and sulphur bacteria, viable non-culturable bacteria. Microbiological water quality management in aquaculture, bio-remediators and probiotics. pathogens of aquatic animals, their isolation and identifications; detection of toxic organisms in aquatic system.

BSH 105 INFORMATION AND COMMUNICATION TECHNOLOGY (1+1=2)

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 E-Mail account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments- tape recorder, public address system, overhead projector, LCD projector. Planning, preparation, presentation of posters, charts, overhead transparencies and slides Organization of an audio visual programme; preparation and presentation of a radio script and T.V. talk.

BSH 107 STATISTICAL METHODS**(1+1=2)****Theory**

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

Practical

Construction of questionnaires and schedules. Exercises on probability, Binomial and Poisson distributions, Area of normal curve confidence interval for population mean, Test of hypothesis based on normal, t, chi-square and F distributions. Simple correlation and regression. Fitting of length - weight relationship in fishes.

PED101 PHYSICAL EDUCATION / NSS / NCC**(0+1*=1*)**

Physical education and its usefulness. Recreation – definition, agencies promoting Recreation. Rules and regulations of important games as well as track events. Swimming its history, hazards in water and safety precautions. Swimming practice – ducking the head, kicking action from the side of the pool, holding breath under water, free style swimming, breast stroke, butterfly stroke, stroke with dolphin kick, breast stroke with turns, regular side stroke and back stroke. Relays and medlays. Use of swimming and floating aids. Diving – safety precaution in diving. Front dive and back dive. Boating – types, maintenance. Methods of life saving in water.

Respiration, suffocation and demonstration of artificial respiration. Wounds and bleeding. Dressings and bandages. Shock. Injuries to muscles and joints. Injuries to bones. Nervous system and unconsciousness. Burns and scalds. Poisoning. Injuries likely to be caused in Fish processing factories and in fishing. Handling and transport of injured persons.

ENG 101 COMMUNICATION SKILLS**(1*+0=1*)**

Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures.

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

SEMESTER-II

FAQ 102 FRESHWATER AQUACULTURE

(2+1=3)

Theory

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources – ponds, tanks, lakes, reservoir, etc. Carrying capacity of pond. 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 recycling and detritus food chain. Use of agro-industrial waste and biofertilizers in aquaculture. Composite fish culture system of Indian and exotic carps - competition and compatibility. Exotic fish species introduced to India and their impact on indigenous species. Culture of other fresh water species: Economics of different culture practices.

Practical

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

FRM 102 TAXONOMY OF SHELLFISH

(1+2=3)

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 identification

FRM 104 BIOLOGY OF FINFISH AND SHELLFISH

(2+1=3)

Theory

Qualitative and Quantitative methods of analysis of stomach contents. Age and growth determination by direct and indirect methods. Reproductive biology – maturity stages, gonadosomatic index, pondoral index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology of finfishes and shell fishes.

Practical

Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking. Visit to shrimp and prawn hatcheries to study developmental stages

Theory

Standard solutions, dilute solutions units of concentration: standard curve; nomograph. Chemistry of water; the water molecule, properties of pure water and sea water. Composition of surface water, ground water and Sea water. Dissolved gasses. Factors affecting natural waters. Acid, base, salts; Hydrogen ions, 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 characteristics: origin and nature of soils. Physical properties of soil; soil color. Soil texture, soil 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, 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. pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil quality criteria/ requirements for aquaculture. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum, environmental ameliorative: chlorination, deodorizers, bacterial formulation.

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, hardness. Determination of inorganic nitrogen, and phosphorus Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon.

Theory

Introduction to limnology: inland water types, their identities and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. Lakes their origin and their 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: character, classification, zonation, seasonal relations, 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; 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 fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Enumeration and biomass estimation of benthos from lakes, ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Methodology for collection and identification of bacteria in freshwaters bodies. Enumeration and biomass estimation of bacteria in freshwater bodies. Inland water body and fish statistics.

PHT 102 FOOD CHEMISTRY AND FISH IN NUTRITION (2+1=3)

Theory

Composition of food & nutritional value. Moisture in foods. Fish lipids in human nutrition, digestion and absorption. Metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Carbohydrates: Naturally occurring polysaccharides in foods, fibre in food and its role. Browning reactions-enzymatic and non-enzymatic. Glycolysis, gluconeogenesis, glycogenolysis, and glycogenesis. Biological oxidation, electron transport chain, P/O ratio; oxidative phosphorylation. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins. Fish muscle proteins, chemical changes in muscle during contraction; Digestion and absorption of proteins; metabolism-amino acid pool; nitrogen balance; essential and non essential amino acids; deamination; decarboxylation; metabolic fate of amino acids. Protein synthesis; 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. Enzymes, vitamins and amino acids, 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, chemical score. Role of fibre in human nutrition.

Practical

Estimation of moisture, crude protein, fat, ash and carbohydrate in food sample. Determination of energy value of foods. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Verification of Beer-Lambert's law. Paper chromatography and thin layer chromatography. Use of pH meter. Estimation of vitamins. Estimation of quality of fish from degraded products of protein and fat.

BSH 102 BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION (1+2=3)

Theory

Theory and applications of Spectrophotometry, Basic principles and applications of chromatographic techniques : TLC, GC, LC, affinity chromatography, HPLC, and ion exchange chromatography. Radio isotopes, Radio Immune Assay, ELISA. Gel filtration, and ultracentrifugation. Blotting: southern, northern, western techniques. Plasmid isolation and cloning, PCR, cell culture and hybridoma technology.

Practical:

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

THE MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES : Definition, Scope and importance, Need for public awareness.

NATURAL RESOURCES : Introduction, Renewable and non-renewable resources - forest resources, water resources, mineral sources, food resources, energy resources, land resources etc, Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.

ECOSYSTEMS : Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, Food webs and Ecological pyramids, Introduction, Types, Characteristic features, Structure and functions of - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, lakes, streams, rivers, estuaries, oceans).

BIODIVERSITY AND ITS CONSERVATION : Introduction - definition of genetic, species, ecosystem diversity, Biogeographic classification of India, Value of biodiversity - consumptive, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega diversity nation, Hotspots 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.

ENVIRONMENTAL POLLUTION : Definition, Causes, effects and control measures of - 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 waste, Role of individuals in pollution prevention, Pollution case studies, Disaster management - floods, earthquakes, cyclones, landslides.

SOCIAL ISSUES AND THE ENVIRONMENT : From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns - case studies, Environmental ethics - issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and nuclear holocaust - case studies, 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 and environmental legislation, public awareness.

HUMAN POPULATION AND THE ENVIRONMENT : Population growth, variation among nations, Population explosion - family welfare program, Environmental and human health, Human rights, Value education, HIV / AIDS, Women and child welfare, Role of information technology in environment and human health.

FIELD WORK : Visits to a local area to document environmental assests, river / forest / grasslands / hill / mountain, Visit to a local polluted site, Study of common plants, insects, birds, Study of simple ecosystems.

Orientation of students towards national problems- study of the philosophy of N.S.S. - fundamental rights, directive principles of the Constitution, socio-economic structure of Indian society, population and five year plans. Functional Literacy - non-formal education of rural youth, eradication of social evil, awareness programmes, consumer awareness, highlights of the Consumer Act, environment enrichment and conservation, health, family welfare and nutrition.

Semester-III

FAQ 201 FISH NUTRITION AND FEED TECHNOLOGY (2+1=3)

Theory

Nutritional requirements of cultivable fish and shellfish. 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 anti-nutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutritional 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.

FAQ 203 CULTURE OF FISH FOOD ORGANISMS (1+1=2)

Theory

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

Practical

Methods of isolation and identification of different live food organism. Laboratory scale culture of selected live food organisms. Evaluation of live food organisms. Decapsulation technique and hatching method of brine shrimp cysts.

FRM 201 INLAND FISHERIES (2+1=3)

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data Inland capture fishery resources of India. and their major fish species composition. Potential of inland waterbodies with reference to respective state. Problems in the estimation of inland fish catch data. Major riverine and estuarine systems of India. Major brackishwater bodies / lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Differences between man-made and natural lakes and flood-plain wetlands as capture fishery resources, 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 gears in inland / estuarine waters. Maintenance of records on catch data.

Theory

Introduction: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Populations of 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. Primary, secondary and tertiary production. Marine food chains and food webs. Vertical migration of zooplankton Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries. Benthos- a life in rocky, sandy, and muddy shores. Mud banks. Mangroves and coral reefs. Boring and fouling organisms. Nekton- outline composition of nekton, habitats of nekton. Bioluminescence and indicator species. Red tides. Biology, significance and classification in mammals, adaptation in pinnipids and cetaceans for breeding. Whales- their different community and their characteristic features. Adaptations in marine mammals for conserving body heat and submersion for long dive.

Practical

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

PHT 201 REFRIGERATION AND EQUIPMENT ENGINEERING**(1+1=2)****Theory**

Laws of thermo dynamics: Different types of heat involved: sensible heat, latent heat, pressure, volume and temperature; thermodynamic cycles; volumetric efficiency; enthalpy; entropy. Refrigeration; Principles of refrigeration; refrigeration cycle; methods of refrigeration; refrigeration systems, air refrigeration system, vapour compression refrigeration system, vapour absorption v system etc. compressors, condensers, receivers, evaporators, expansion valves, auxiliary equipments, oil, liquid trap systems; accumulators; non condensable gases; defrosting system, oil and refrigerant charging; study of automatic control devices; refrigerant and their properties. Layout and construction of freezing plants, cold storage, contact plate freezer, immersion freezer, tunnel freezer, air blast freezer, air lock system, anti room arrangements. Ice manufacturing unit, marine refrigerating plant; methods of defrosting; insulating material. Refrigerating effect, cooling estimate, heat load calculation, wall heat gain load, air change load, product load, miscellaneous load, refrigeration system capacity and running time.

Fishing vessel auxiliary systems: Auxiliary engines, drives, mechanical drive, hydraulic drive, pneumatic drive, electric drive, bilge pumping systems, other amnesties. Deck and fish hold; Deck design: Deck design and layout, wheel house, hatches, lifting and hauling gear, controls, fish hold, position, access, space, filling, lining and insulation, drain and shell fish storage tanks. Anchors and mooring: Types of anchors, chains, ropes, blocks, leads and drogues. Fish finding equipments: Echo sounder, fish finders, sonar and net sonde. Fish processing equipments: Equipments commonly available in processing units. Different types of ice making machinery, brine tank, brine solution; leak detection arrangements; operation of various machinery used in freezing; machinery for sausage making, canning, fish products, by-products and packaging. Special equipment for freeze-drying; irradiation and cryogenics; general maintenance of freezing plant, cold storage and ice plant.

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.

BSH 203 ECONOMICS

(2+1=3)

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macro-economics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production etc. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, consumer’s 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. 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.

Globalisation: 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. Economic analysis on cost, return and break even of any two production units like fish farm / shrimp farm / seed production unit / fish processing plant / export unit. Preparation of enterprise budget for integrated fish farming. Contribution of fisheries to Indian Agriculture and total GDP – a trend analysis. 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

Semester-IV

FAQ 202 AQUACULTURE ENGINEERING

(2+1=3)

Theory

Land survey, area calculation of plane surface of regular and irregular shape as applied to measurement of land, trapezoidal rule, Simpson's rule, volume of regular and irregular shape as applied to the volume of stacks, sheds, heaps. Farm-types and objectives; Fresh water and coastal aquafarms. Preliminary survey, site selection, topography. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contour surveying; Soil – types, properties, classification, sampling methods and texture analysis. Location, design and construction of hatcheries, race ways and farm complex. Tide-fed / pump fed farms, creeks, estuarine and marine water source utilization. Open canals and their types. Sluices and gates. Earth work calculation – ponds, dykes, canals and roads. Design and construction of ponds and dykes. Tidal influences and maintenance; Effect of seepage and evaporation and their control. Water budgeting. Water distribution system – main feeder channel, drainage channel. Water control structure – types of inlets and outlet and their construction. Computation of water intake and discharge. Aerators – principles, classification and placement. Pumps - types, total head and horse power. Filters – types and construction.

Practical

Evaluation of potential site for aquaculture. Land survey – chain, compass, level, plane table, and contouring; soil analysis for farm construction. Site survey: preparation of site and contour maps. Design and lay out of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes, sluices and channels. Earth work calculation. Calculation on water requirement. Pumps: design and operation. Design and operation of filters and aerators. Visit to different types of farms.

FAQ 204 ORNAMENTAL FISH PRODUCTION AND MANAGEMENT

(1+1=2)

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 filtration system – biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decoratives. 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. Aquarium accessories and equipments. Conditioning and packing of ornamental fishes. Preparation of feed. Setting-up of breeding tank for live bearers, barbs, goldfish, tetras, chichlids, gauramis, fighters and catfishes. Identification of fish diseases and prophylactic measures.

Theory

An over view 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, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), seaweeds, etc. Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi-intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of aquaculture - rafts, racks, cages, poles and ropes. Seed resources, 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.

FRM 202 PHYSIOLOGY OF FINFISH AND SHELLFISH**(2+1=3)****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. Structure and functions of important endocrine glands

Practical

Estimation of oxygen consumption, ammonia excretion and carbon-di-oxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques. Histochemistry of pituitary gland Demonstration of osmotic phenomenon - Exosmosis and endosmosis.

PHT 202 FISHING CRAFT TECHNOLOGY**(1+1=2)****Theory**

Introduction: History & development of fishing crafts. Traditional fishing crafts of India: Inland & marine waters. Inland & marine waters. Classification of fishing crafts based on fabrication, dimension, nature of fishing, depth of operation etc. catamaran, canoe, Nava, Satpati, etc. Geography, weather, sea worthiness etc. Boat building materials - Various types of boat building materials: wood, steel, Ferro cement, aluminum & fiberglass; their preparation, seasoning, preservation & their advantages & disadvantages. Choice of construction material; comparison of mechanical properties. Boat design - Important terminologies of fishing vessel & related to fabrication: keel, hog keel, waterline, designed waterline, water plane, GRT, depth, draft, stem, stern etc. Drawing conventions in naval architecture. Form co-efficient & ratios: block co-efficient. Water plane co-efficient, length beam ratio, beam depth ratio etc. Design procedure: Displacement- weight equation; estimation of light weight ship; Basic mathematics & Hydrodynamics for designing of fishing vessels: density, specific gravity, law of floatation, condition of equilibrium, fluid pressure, center of pressure etc; calculation of displacement; calculation of water plane area; tones per centimeter, trim; moment of change trim to one cm; uses of

hydrostatic curves. Stability of fishing vessel, Longitudinal stability such as pitch & trim, Transverse stability such as list, heel, meta center, meta centric height, righting lever, righting moment, etc. Various equilibrium of ships such as stable, unstable & neutral. Basic resistance of boats: drag, waves, water current, fractional resistance, eddy resistance etc. Marine engines & propellers: powering basics: wake, propeller efficiency, thrust, hull efficiency, quasi-propulsive coefficient, power margin, power rating normal HP, maximum power. Introduction to marine engines & different types of engines. Engine components & its performance. Different types of engine systems. Outboard engines working & maintenance. Estimation of engine power for fishing vessel. Marine propeller types, characters & selection of propellers. Boat construction methods: construction of wooden boats, itemization of construction, back bone assembly, mold preparation, U & V bottom type selection, planking etc. Construction of steel boat: types of construction, keel arrangement, plating, welding etc. Construction of fiber glass boat: fiber resin preparation, types of construction, mold types, mold preparation & fabrication etc. Construction of Aluminum & Ferro-cement boat: keel assembly, mortar preparation, sheathing, etc. Deck-fittings & maintenance - common fouling & boring organisms: common species, nature of degradation, prevention measures etc, Preservation & maintenance of various types of hull: painting, metal sheathing, galvanisms, chemical treatment dry docking etc. Stern gear assembly: stern tube, propeller shaft etc. Deck fitting & fishing equipment: mast, derrick, gallows, gantry, boom, outrigger, trawl winch, triplex, power block, gurdy, line hauler, etc. Rules & regulations for fishing vessel fabrication, operation & safety.

Practical

Study on Traditional crafts & various boat building materials. Introduction to engineering drawing: Lettering & dimensions. Projection & its styles. Simple projection & complex projection of an object. Drawing of traditional crafts: catamaran & Satpati, etc. Drawing of backbone assembly & U & V bottom hull of wooden boat. Lines plan drawing of small fishing vessel: body plan, profile & half breadth plan. Drawing of deck lay outs of various fishing crafts: Trawlers, gill netters, long liners, squid jiggers etc. Designing of fishing vessel from a parent vessel. Study of propeller & stern gear assembly. Study on marine fouler & borers. Visiting to harbors, boat building yards & dry docking yard.

PHT 204 CANNING AND FISH PACKAGING TECHNOLOGY (2+1=3)

Theory

Introduction to canning principle. Historical developments. Containers- can making materials and cans, characteristics of seam. Steps in canning- raw materials, preparatory treatments. Precooking, packing, exhausting, seaming, thermal processing, cooling and storage. Thermal processing – heat resistance of microorganisms, heat penetration, graphical method of formulation. Fo- value. Canning of commercially important fishes, shellfishes and other food products- salient features. Retort pouch packing – principles and techniques; HTST process and aseptic packing- principles and techniques spoilage of canned foods- types, causes and preventive measures. Introduction to food packaging- objectives and requirements. Characteristics of various packaging materials – metals, paper and paper boards, corrugated fibre board, plastics, multi-layer lamination, testing of packaging materials and containers. Environmental aspects of food packaging.

Practical

Types of cans, canning equipments and layout of cannery. Canning of different varieties of fish and shell fish. Cut out test of canned products. Examination of can double seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method, spoilage condition in canned products. Familiarization with various packaging materials and container for fish products. Assessment of quality of packaging materials used for packaging fish and fishery products. BIS specifications for plastics for food contact applications and other regulations.

Theory

The earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of Topography and Terminology; Major Divisions: Continental margin, Ocean basin floor, Mid ocean ridge system, Deep sea trenches and deeps, Relief in Indian oceans. Ocean Waves: Definition and terms; classification Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino. 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. Concept of SONAR channel and shadow zone. Color of the sea. 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; CO₂ system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.

Practical

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

BSH 202 FISHERIES ADMINISTRATION AND LEGISLATION**(2+0=2)**

Introduction to public administration, principles of organization and management of public enterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. 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. Fisheries development over Five Year Plans. 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. 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.

Semester-V

FAQ 301 FINFISH BREEDING AND HATCHERY MANAGEMENT

(2+1=3)

Theory

Fresh water and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Temporary storage of spawn, Behaviour of spawn in relation to hydrological and hydrobiological factors. 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. Types of fish egg and embryonic development. Methods of breeding; bundh breeding, wet and dry bundhs, method of breeding carps in bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warm water fin fishes, environmental factors affecting spawning and breeding, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Broodstock management and transportation broodfish. 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. Treatment of eggs. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps. Mahaseer, trout, tilapia, catfishes, mullets, milk fish, pearl spot, sea bass, groupers, etc. Multiple breeding of carps. Cryopreservation of fish gametes.

Practical

Study of maturity stages in fish. Collection and preservation of fish pituitary gland, preparation of extract, Hypophysation. Calculation of fecundity. Broodstock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stage. 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. Cryopreservation of fish gametes. Breeding and larval rearing of common finfishes.

FAQ 303 SHELLFISH BREEDING AND HATCHERY MANAGEMENT

(2+1=3)

Theory

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachium rosenbergii*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, sea horse, horse-shoe carb, *Sepia*, *Loligo*, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon*. Induced maturation in *Penaeus monodon* by eye stalk ablation. Reproductive hormones 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 and bivalves. 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. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon*. 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 broodstock. Practice in the operation of shrimp and prawn hatcheries. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.

Theory

Significance of fish diseases in relation to aquaculture. Disease development process in fish and shellfish. Defense mechanism in finfish and shellfish- specific and non specific immune system. Role of stress and host defense mechanism in disease development. Host, pathogen and environment interaction. Pathogenicity and mechanism of bacterial, viral and fungal infections of finfish and shellfish. Morphology, Biology and life cycle of parasites. Infectious diseases of cultured finfish and shellfish. Important disease epizootics of wild fish population. Zoonotic diseases. OIE listed and notifiable diseases.

Principles of disease diagnosis. Case history and clinical sign in diagnosis. Conventional and rapid diagnostic techniques. Microscopical, microbiological, histopathological and biochemical methods. Antibody and nucleic acid based rapid diagnostics. Health management in aquaculture. Drugs, chemicals, antibiotics and probiotics used in aquaculture and their mode of action. Preventive strategies. Principles and methods of vaccine production and fish immunization. Quarantine and health certification in aquaculture. Crop rotation, Immunostimulants, bioremediation and polyculture as strategies for health management.

Practical

Methods of sampling fish and shellfish for disease diagnosis. Live and post mortem examination of diseased fish. Collection and identification of parasites. Morphological, biochemical and biological tests of bacteria, virus and fungi. Antibiotic sensitivity assays. Techniques in histology. Pathological changes in different organ systems associated with different pathogens. Methods of treatment.

FRM 301 MARINE FISHERIES**(2+1=3)****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.

AEN 301 ECOLOGY AND BIODIVERSITY**(2+1=3)****Theory**

Ecology: Definition; Ecological Hierarchy; Subdivisions of Ecology, Ecosystem: Principles and concepts; Examples of Ecosystems: The Pond, The Micro ecosystem; Production and Decomposition; Homeostasis of the Ecosystem, Energy flow: Definition; Laws of Thermodynamics; Energy Environment ; Concepts of Productivity; Measurement of primary productivity; Trophic Levels, and Examples; Ecological Pyramids. Biogeochemical Cycles: Patterns and Basic types, cycling of Organic nutrients; Pathways, Limiting factors and governing laws. Ecological Indicators., Community Ecology: The biotic community, Ecological Dominance; community analysis; species diversity in communities; patterns in communities, ecotones, Population ecology: population group properties, population density and indices of relative abundance. Types of interaction – animal association- Symbiosis, commensalisms, parasitism, etc., Autoecology: Concepts of habitat and ecological Niche; Natural Selection; Artificial Selection. The freshwater environment and types: wetlands: dominant flora and

fauna. Coastal Ecosystems coastal Zone and its classification. Estuaries- classification; physico-chemical factors; biota and productivity; example of some Indian estuaries. Mangroves- definition, mangrove plants, factors affecting distribution. Mangrove flora and fauna. Conservation of habitats: endangered species and their conservation, fish passes for migratory fishes, protected areas, marine parks and sanctuaries, mangrove afforestation. Artificial reefs. Conservation programmes for endangered species.

Practical

Visit to a lake, natural pond\estuaries \swamp\marsh\river\flood plain\ reservoir and marine protected areas. Study of the habitat, biotic communities, and species diversity and their adaptive characters/ associations. Visit to a mangrove forest, collection and identification of mangrove flora and fauna. Visit to a rocky shore to study zonation and physico-chemical conditions. collection and identification of Rocky shore flora and fauna. Visit to a sandy shore shore to study zonation and physico-chemical conditions. collection and identification of sandy shore flora and fauna. Visit to a muddy shore to study zonation and physico-chemical conditions. collection and identification of muddy shore flora and fauna. Collection and identification of corals and coral reef biota. Visit to marine structures on the coast, collection and identification of Borers and Foulers organisms, assessment of the damages and appraisal of remedial measures. Visit to a marine park/sanctuary. Understanding the steps involved in protecting endangered habitats and species (Horse shoe crab, Marine turtles, sharks and marine mammals)

PHT 301 NAVIGATION AND SEAMANSHIP (1+1=2)

Theory

Navigational aids, magnetic compass, gyro compass, sextant, bearing instruments, their construction errors and use. Chart- abbreviations and symbols, type of charts and chart reading. Sounding instruments- lead lines and echo sounder, their principles and use. Measurement of speed, patent log and electric log, principle and construction. Pilot signals, distress signals and penalty for their misuse, procedure for sending distress signals by radio telephony. Fire fighting and life saving appliances to be carried on board a fishing vessel as per F.F.A and L.S.A rules 1978. Their maintenance curriculum, day and night signals for vessel engaged in fishing. Manning requirement of fishing vessel. Electronic navigation and communication aids; principles of radio transmitter and receiver, direction finder, auto direction finder, V.H.F. radio telephone, DECCA navigator- parts and functioning. Sonar block diagram, functioning; Net sonde- trawl eye- trawl link radar, video, G.P.S.

Practical

Changing from true course to compass and from compass course to true course with or without wind. To find the course to steer time required from and to given positions. To find position reached after steering a given course and speed. To find the position of the vessel by the different methods and to find compass error and deviation by transit bearing of two shore objects. To study different types of knots and bends and their use at the sea. Operation of echo sounder, V.H.F. sonar, satellite navigator, radar, direction finder- preparation of block diagrams. Global positioning system.

PHT 303 FISHING AND GEAR TECHNOLOGY (2+1=3)

Theory

Introduction: History and development of fishing gears; hand picking use of animals, lines and nets etc. classification of fishing gears of world and India. Factors that determine selection of fishing gears. Gears used in relation to fish and fishing area. Fishing gear materials - Classification of fishing gear materials; natural and synthetic fishing gear materials. Natural fibre, yarns, twines – ropes its properties and identification methods. Synthetic fibres, fibre types, yarns, twines, ropes-its properties, raw materials of synthetic fibres. Identification of synthetic fibres, tests, visual test, water test, burning test and solubility test. Yarn numbering systems – direct, indirect, count denier, tex, metric system, runnage, conversions. Twist in twines and ropes, braiding ropes, leaded ropes, floated ropes. Netting – types of knots, knotless netting, meshes, braiding, shaping, creasing, baiting, tailoring. Mounting of webbing –

Semester-VI

FAQ 302 FISH BIOTECHNOLOGY AND BIOINFORMATICS (1+1=2)

Theory

Organization of genome in prokaryotes and eukaryotes. Mutation and mutagens. Genetic code. Concept of replication, transcription and translation. Recombinant DNA technology. Transgenesis, Vaccines, cell culture, hybridoma technology, monoclonal antibody production, Diagnostic kits- ELISA, Immunoblot, PCR, Hybridisation. Biosensors, Bioprocessing. Concept of Bioinformatics - NCBI, Genebank sequence database-primary and secondary databas

Practical

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

FAQ 304 FISH GENETICS AND BREEDING (1+1=2)

Theory

Principles of genetics and breeding, Gene and chromosome as unit of inheritance, Structure of genetic material. Chromosomal structure and aberrations. Laws of inheritance. Linkage and crossing over. Sex determination. Chromosome and gene manipulation. Population parameters. Gene and genetic frequency. Hardy-Weinberg law and its significance. Inbreeding and its consequences. Selection methods and breeding plans. Heritability and significance.

Practical

Problems on Mendelian inheritance, linkage and crossing over. Problems on gene and genotypic frequency. Estimation of relationship coefficient. Genetic gain and genetic improvement. Heritability estimation. Chromosome preparation.

FRM 302 FISH POPULATION DYNAMICS AND STOCK ASSESSMENT (2+1=3)

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. 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. Yield isopleth diagrams. Interpretation of yield curves. Open access fisheries. Growth over-fishing. Recruitment over-fishing and fisheries regulations (fleet regulation, mesh regulation, closed season and areas, total allowable catch and individual quota system). Population parameters- growth, mortality, recruitment and selection. CPUE, trawl selection and gillnet selection. Analytical models of fish stocks. GIS and remote sensing in fisheries management.

Practical

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

Theory

Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; The Coliformes Tests; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution. Environmental Impact Assessment for fisheries and aquaculture projects. Functions and working of pollution control boards. Coastal zone-definition, importance. Anthropogenic activities and their impact on coastal zones; agriculture, aquaculture, waste disposal, property and infrastructure development, ports and shipping, tourism (beach and coral reef), industries (petroleum industry, heavy industry, forest industry), mining and marine excavations, water supply projects. Goals and purposes of CZM. Management methods and information: public awareness and environment policy, general coastal zone programs, shore lands management, coastal water basin protection, coastal water quality protection, harvestable resources, and ecosystem restoration. Coastal Regulation Zone (CRZ) Act, Environment impact assessment (EIA). Integrated Coastal Zone Management (ICZM). International treaties and conventions. Preparation of projects based on the provided Guidelines and Standards for Coastal Projects- aquaculture. Power plants, disasters, etc.

Practical

Water and sediment sampling devices, Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Study of pathogenic and coliform bacteria. Bacteriological quality of water; Colliform tests, IMViC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters. Pollution flora and fauna: indicator species- algae, protozoa and insect larva. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.

PHT 302 FISH PRODUCTS AND BY-PRODUCTS TECHNOLOGY**(2+2=4)****Theory**

Principle of fish preservation by different methods. Preservation of fish by traditional method – salting, sun drying, smoking, marinating and fermentation. Theory of salting, methods of salting –wet salting and dry salting. Drying and dehydration- theory, importance of water activity in relation to microbial growth .Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish. Fish preservation by smoking- chemical composition of wood smoke and their role in preservation. Methods of smoking

and equipments used for smoking. Carcinogenic compound in wood and methods to remove them. Marinaded and fermented fish products – role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibriller protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products. Fish meal and oil. Dry reduction and wet reduction methods. Fish maws, shark leather, Chitin, chitosan, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach de mer, and biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc and imitation products. Value addition, HACCP in safe products production.

Practical :

Preparation of fish manure. Preparation of fishmeal. Preparation of fish body oil. Preparation of fish liver oil. Preparation of fish maws and isinglass. Preparation of fish silage and ensilage. Preparation of fish glue. Preparation of fish gelatin. Preparation of fattice. Preparation of pearl essence. Preparation of chitin and chitosan. Quality assessment of individual by-products. Preparation of salted fish by different methods. Drying- Preparation of sun dried fish, salted fish, artificially dried fish. Quality assessment of salted and dried fish. Preparation of smoked product using smoking kiln - cold smoking and hot smoking. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinaded products.

PHT 304 FISH MICROBIOLOGY AND QUALITY ASSURANCE (2+2=4)

Theory

History of micro-organisms in foods; role and significance of micro-organisms in nature and in foods. Micro-organisms in fish; intrinsic and extrinsic parameters of fish that affect microbial growth. Characteristics of psychrophiles, halophile and thermophiles, their role in spoilage, food poisoning. Determining incidence and types of microorganisms(All food borne human pathogens Vibrio, E coli, Salmonella, listeria, Clostridia, Campylobacter etc) and their products in fish. Study of micro-organisms in food by conventional and rapid techniques. Encapsulation – endospores, formation of cell aggregates, Fish preservation by use of chemicals, low temperature, high temperature drying, irradiation, fermentation, etc. Study of food pathogens, infections, intoxication and other biological hazards like mycotoxins, parasites, viruses, marine toxins, etc. Types of spoilage of fish, semi processed and processed fishery products, Indices of fish sanitary quality, Concept of Quality Management; TQM, SSOP, GMP; ISO and Codex Alimentarius; HACCP, Microbiological standards and criteria, BIS and codex standards for fish and fishery products. Process water quality. Fish plant sanitation. Disinfectants, detergents and cleaning schedule

Practical

Study of micro-organisms associated with finfish and shellfish. Micro-organisms causing different types of spoilage of fish and fishery products. Isolation of pathogens associated with fish and fishery products. Effect of chemical and physical preservatives on spoilage organisms. Microbiological quality control-conventional and rapid methods. Visit to factory & Study of Hazard analysis Critical Control Point (HACCP) system and its implementation.

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 behaviour 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.

Practical

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on price, quantity and cost of living indices; 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.

BSH 304 ENTREPRENEURSHIP DEVELOPMENT**(1+1=2)****Theory**

Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalisation and the emerging business / entrepreneurial environment. 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. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to fisheries sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of aqua inputs industry. Characteristics of Indian fish processing and export industry. Social Responsibility of Business.

Practical / Case studies

Spotting business opportunities and exploring entrepreneurial possibilities in different sectors of fisheries industry; developing a pilot project based on identified business; case studies of successful and failed entrepreneurs. Critical review of Agri business clinics and e-chaupals. Case studies from aqua industry / fish processing industry. Exercises in business environmental analysis.

Semester-VII

“Hands-on Training” (Experiential Learning)

0+25

A minimum of two areas should be decided by each university as detailed below depending upon local needs and industrial demand. It is expected that the students will prepare a business / work plan for the relevant area of specialization. An end-to-end approach is to be followed in implementing the program. (For example, in processing : the program may start with raw material procurement, and include processing, packaging and storage, organize resources and utilities, sell the product, maintain accounts and documents, wind-up production and submit a report of performance). While identifying the area of specialization, the college shall take into account the faculty and infrastructure facilities available and their regional significance. The students shall also be permitted to take modules across the areas of specializations, based on the structure of the specialization. All the students shall be provided with an advisor, who will guide the students in “Hands-on Training”. A total of 25 credits are allotted for “Hands-on Training” and the evaluation of the same shall be conducted by the Committee appointed by the Dean of the respective college.

(I) POST HARVEST TECHNOLOGY

(25 CREDITS)

No	Activity	Credits
1	Preparation of project plan	4
	Project Formulation, Finance Mobilisation patterns, Business Management	
2	Preparation of ready to eat value added products	6
	Selection of viable product, Selection of raw material, Recipe standardization, Preparation of products,	
	Packaging and marketing	
3	Cured products preparation and marketing	5
	Selection of viable method of drying, Raw material procuring, Development of dried products,	
	Packaging & marketing	
4	Fresh fish marketing	
	Fresh fish dressing, packing, transportation, marketing, cold chain / Live fish marketing	
5	Food safety and Quality assurance	7
	Development of HACCP plans for different products, Analytical methods for different bacteria and quality monitoring parameters	
6	Documentation and reports	2
	Book keeping, Human Resource management, Preparation of final report	
7	Oral examination	1
	Presentation, Oral performance	
	Total	25

(II) SEED PRODUCTION

(25 CREDITS)

No	Activity	Credits
1	Preparation of work plan	4
	Target seed production, broodstock requirement, Infrastructure facility, Inputs, Supplies and marketing	
2	Species and site selection	2
	Species selection	
	Site selection	
3	Hatchery	6
	Layout plan, design, construction / fabrication, operational management	
	Broodstock management, live food production	
4	Breeding	5
	Selection of brooders, acclimatization, induced breeding, collection and estimation of eggs and spawn, packing and transportation.	
5	Nursery and Rearing pond management	5
	Pre-stocking and post-stocking management, harvesting, packing, transport and supply	
6	Documentation and reports	2
	Book keeping, Human Resource management, Preparation of manual and final report	
7	Oral examination	1
	Presentation, Oral performance	
	Total	25

SEMESTER-VIII

Fisheries work experience

(0+20=20)

Fishery Work Experience	Duration	Credit
a. Orientation	1 week	---
b. Aquaculture work experience	5 weeks	6
c. Processing Plant Experience	5 weeks	6
d. Fishing Experience	2 weeks	2
e. Catch composition analysis	1 week	1
f. Socio-economic Surveys	1 week	1
g. Preparation of Project Reports studies and their evaluation	1 week	1
h. Functioning of Fishery Co-operative and Fish Marketing	1 week	1
i. Evaluation and assessment	1 week	1
j. Study tour	2 weeks	1
	20 weeks	20