

VIDYASAGAR UNIVERSITY



Syllabus
Of
B.Sc. in Fishery Science
[w.e.f.: 2021-2022]

The syllabus has been prepared as per the Fifth Dean Committee recommendation of ICAR

PROGRAMME OUTCOME

**SYLLABUS
FOR
B.Sc. in Fishery Science**

FIRST SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEAK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS101	Principles of Aquaculture	1	1	2	20	50	30	100
2	BFS102	Taxonomy of Finfish	1	2	3	20	50	30	100
3	BFS103	Taxonomy of Shellfish	1	2	3	20	50	30	100
4	BFS104	Meteorology and Geography	1	1	2	20	50	30	100
5	BFS105	Principles of Biochemistry	2	1	3	20	50	30	100
6	BFS106	Fundamentals of Microbiology	2	1	3	20	50	30	100
7	BFS107	Information & Communication Technology	1	1	2	20	50	30	100
8	BFS108	Fishery Economics	1	1	2	20	50	30	100
Total of Semester					20	800			

SECOND SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEAK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS201	Freshwater Aquaculture	2	1	3	20	50	30	100
2	BFS202	Anatomy of Finfish and Shellfish	2	1	3	20	50	30	100
3	BFS203	Biology of Finfish and Shellfish	2	1	3	20	50	30	100
4	BFS204	Soil and Water Chemistry	1	2	3	20	50	30	100
5	BFS205	Limnology	2	2	4	20	50	30	100
6	BFS206	Food chemistry and Fish in Nutrition	2	1	3	20	50	30	100
7	BFS207	Biochemical Techniques and Instrumentation	1	2	3	20	50	30	100
Total of Semester					22	700			

THIRD SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEAK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS301	Fish Nutrition and Feed Technology	2	1	3	20	50	30	100
2	BFS302	Culture of Fish Food Organisms	1	1	2	20	50	30	100
3	BFS303	Inland Fisheries	2	1	3	20	50	30	100
4	BFS304	Oceanography	2	1	3	20	50	30	100
5	BFS305	Marine Biology	2	1	3	20	50	30	100
6	BFS306	Refrigeration and Freezing Technology	2	1	3	20	50	30	100
7	BFS307	Statistical Methods in Fisheries	1	1	2	20	50	30	100
Total of Semester					19	700			

FOURTH SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEAK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS401	Aquaculture Engineering	2	1	3	20	50	30	100
2	BFS402	Ornamental Fish Production and Management	1	1	2	20	50	30	100
3	BFS403	Coastal Aquaculture and Mariculture	2	1	3	20	50	30	100
4	BFS404	Physiology of Finfish and shellfish	2	1	3	20	50	30	100
5	BFS405	Fishing Craft and Gear Technology	2	2	4	20	50	30	100
6	BFS406	Canning and Fish Packaging Technology	1	1	2	20	50	30	100
7	BFS407	Extension Education in Fisheries	1	1	2	20	50	30	100
8	BFS408	Fisheries Administration and Legislation	2	0	2	20	50	30	100
Total of Semester					21	800			

FIFTH SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS501	Finfish Breeding and Hatchery Management	2	1	3	20	50	30	100
2	BFS502	Shellfish Breeding and Hatchery Management	2	1	3	20	50	30	100
3	BFS503	Diseases and Management	2	2	4	20	50	30	100
4	BFS504	Marine Fisheries	2	1	3	20	50	30	100
5	BFS505	Aquatic Ecology and Biodiversity	2	1	3	20	50	30	100
6	BFS506	Navigation and Seamanship	1	1	2	20	50	30	100
7	BFS507	Disaster Management in Fisheries	1	1	2	20	50	30	100
Total of Semester					20	700			

SIXTH SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS601	Biotechnology & Bioinformatics in Fisheries	1	1	2	20	50	30	100
2	BFS602	Fishery Genetics and Breeding	1	1	2	20	50	30	100
3	BFS603	Fish Population Dynamics and Stock Assessment	1	1	2	20	50	30	100
4	BFS604	Aquatic Pollution and Coastal Zone Management	2	1	3	20	50	30	100
5	BFS605	Fish Products and Byproducts Technology	2	1	3	20	50	30	100
6	BFS606	Fish Microbiology and Quality Assurance	2	2	4	20	50	30	100
7	BFS607	Financing and Marketing Management in Fisheries	1	1	2	20	50	30	100
8	BFS608	Entrepreneurship Development and Communication Skills	1	1	2	20	50	30	100
Total of Semester					20	800			

SEVENTH SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS701	Hands-on Training in Fisheries (Experiential Learning)	0	20	20	0	0	100	100

EIGHTH SEMESTER

SL NO	PAPER CODE	COURSE TITLE	CONDUCT HOURS PER WEEK			MARKS			
			L	P	CREDITS	Int Asst.	Theory	Practical	Total
1	BFS801	In-plant training in Fisheries	0	20	20	0	0	100	100

**FIRST SEMESTER
PRINCIPLES OF AQUACULTURE**

Code: BFS 101**Full Marks - 100****1L+1P=2****Credit-2**

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 water. Principles of organic aquaculture. 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.

Recommended Books:

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

TAXONOMY OF FINFISH

Code: BFS 102**Full Marks - 100****1L+2P=2****Credit-3**

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

Practical: Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA polymorphism; Visit to fish landing centres to identify commercially important fishes and catch composition.

Recommended Books

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

TAXONOMY OF SHELLFISH**Code: BFS 103****Full Marks - 100****1L+2P=2****Credit-3**

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 of commercially important shellfishes.

Recommended Books:

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

METEOROLOGY AND GEOGRAPHY**Code: BFS 104****Full Marks - 100****1L+2P=2****Credit-3**

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.

Recommended Books

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

PRINCIPLES OF BIOCHEMISTRY

Code: BFS 105

Full Marks - 100

2L+1P=3

Credit-3

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, structure, 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; Determination of saponification and iodine values. Determination of lipase activity. Gel filtration. Preparation of tissue homogenate and organelle isolation.

Recommended Books

1. Leninger, A.L. 1990. Biochemistry, CBS publishers and Distributors Pvt. Ltd., Shahdara, Delhi.
2. Wilson, K. and Walker, J. 2000. Practical Biochemistry: Principles and Techniques. University of Cambridge, UK.
3. Eric, E. C., Paul K., Stum P.F., George, B. and Roy, H. D. 1995. Outlines of Biochemistry, John Wiley and Sons, Inc., Canada.
4. Palanivelu, S. and Shanmugavelu, S. 1993. Principles of Biochemistry and Biotechniques. Palani paramount publications, Madurai.
5. Prakash, M. and Arora, C.K. 1998. Laboratory Instrumentation, Anmol Publications Pvt. Ltd. New Delhi.

FUNDAMENTALS OF MICROBIOLOGY

Code: BFS 106
2L+1P=3
Credit-3

Full Marks - 100

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, chemoautotrophs 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 microorganisms 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.

Recommended Books

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

INFORMATION & COMMUNICATION TECHNOLOGY

Code: BFS 107
1L+1P=2
Credit-2

Full Marks - 100

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.

Recommended Books:

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

FISHERY ECONOMICS

Code: BFS 108
1L+1P=2
Credit-2

Full Marks - 100

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. Preparation of enterprise budget for integrated fish farming. 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

Recommended Books:

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

SECOND SEMESTER**FRESHWATER AQUACULTURE**

Code: BFS 201
2L+1P=3
Credit-3

Full Marks - 100

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.

Recommended books:

1. Jhingran, V.G. 1998. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
2. Huet Marcel. 1972. Text book of fish culture. Oxford Fishing news books.
3. Santhanam, R., Sukumaran, N. and Natarajan, P. 1987. A manual of Aquaculture. Oxford- IBH, New Delhi.
4. Srivatsava. 1993. Freshwater Aquaculture in India, Oxford and IBH Publishing Co.Pvt.Ltd., New Delhi.

ANATOMY OF FINFISH AND SHELLFISH

Code: BFS 202
2L+1P=3
Credit-3

Full Marks - 100

Study of internal anatomy of important groups of shellfish and finfish. Cell structure, tissue and body organization. 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. Structure of endocrine glands.

Recommended books:

1. Lagler, K.F. et al. 1977. Ichthyology 2nd Edition. John Wiley & Sons, Inc. Canada.
 2. Bone, Q. et al. 1995. Biology of Fishes. Blackie Academic & Professional, London.
- Kumar, S. and Tembhre, M. 1996. Anatomy and Physiology of Fishes. Vikas Publishing House Pvt. Ltd.,

New Delhi.

Munshi, J.S.D. 1995. Fish Morphology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

BIOLOGY OF FINFISH AND SHELLFISH

Code: BFS 203

Full Marks - 100

2L+1P=3

Credit-3

Study of food and feeding habits of commercially important fish. 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. Tagging and marking of finfish and shellfish.

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

Recommended books:

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

SOIL AND WATER CHEMISTRY

Code: BFS 204

Full Marks - 100

1L+2P=3

Credit-3

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. Determination of soil texture, water holding capacity, 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.

Recommended books:

1. Boyd, C.E. 1990. Water Quality in Ponds for Aquaculture. Alabama Agricultural Experimental Station, Auburn University, Alabama, USA.
2. Harry O. Buckman and Nyle C. Brady. 1963. The Nature and Properties of Soils. The Macmillan Company, New York.
3. APHA. 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edition, American Public Health Association, Washington.
4. Chattopadhyay, G.N. 1998. Chemical analysis of Fish Pond Soil and Water. Daya Publishing House, Delhi.
5. Hobart, H. Willard, L., Merritt, Jr., John A. Dean and Frank, A. Settle, Jr. 1986. Instrumental Methods of Analysis. Sixth Edition. CBS Publishers and Distributors, Delhi.
6. Ramadhas, V. and R. Santhanam. 1996. A Manual of Methods of Seawater and Sediment analysis. Fisheries College & Research Institute, Tuticorin.

LIMNOLOGY

Code: BFS 205

Full Marks - 100

2L+2P=4

Credit-4

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

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

Recommended books:

1. Welch, Paul S. 1952. Limnology. McGraw-Hill Book Company, Inc., New York.
2. Horne, Alexander J. and Goldman, Charles R. 1994. Limnology. McGraw Hill Inc. New York.
3. Edmondson, W.T. (ed.). 1992. Ward & Wipple's Freshwater Biology. International Books & Periodicals Supply Service, New Delhi.
4. Hutchinson, G. Evelyn. 1975. A Treatise on Limnology: Volume I (Parts 1 and 2), Volume II, and Volume III. Wiley Interscience, New York.
5. Hynes, H.B.N. 1972. The Ecology of Running Waters. University of Toronto Press, Toronto
6. Tonapi, G.T. 1980. Freshwater Animals of India: An Ecological Approach. Oxford IBH, New Delhi.
7. Wetzel, Robert G. and Gene E. Likens. 1991. Limnological Analyses. Springer-Verlag, New York.

FOOD CHEMISTRY AND FISH IN NUTRITION

Code: BFS 206

Full Marks - 100

2L+1P=3

Credit-3

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.

Recommended books:

1. Halver, J.E. 1989. Fish Nutrition, Academic Press, San Diego, CA.
2. NRC. Nutritional Requirements of Warm Water Fishes. National Academy of Sciences, Washington.
3. Lovell, R.T. 1998. Nutrition and feeding of fishes, Chapman & Hall, New York.
4. New, M.B. 1987. Feed and feeding of fish and shrimp. A manual on the preparation and preservation

of compound feeds for shrimp and fish in aquaculture. F.A.O. Rome.

5. Sena S.De Silva, Trevor A.Anderson. 1995. Fish nutrition in aquaculture, Chapman & sHall Aquaculture Series, London.
6. Swaminathan, M. 1985. Hand book of Food and Nutrition – The Bangalore Printing and Publishing Company, Ltd. Mysore road.

BIOCHEMICAL TECHNIQUES AND INSTRUMENTATION

Code: BFS 207

Full Marks - 100

1L+2P=3

Credit-3

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 blotting techniques and PCR. Sub-cellular fractionation by centrifugation.

1. Recommended books:
2. Leninger, A.L. 1990. Biochemistry, CBS publishers and Distributors Pvt. Ltd., Shahdara, Delhi.
3. Wilson, K. and Walker, J. 2000. Practical Biochemistry:Principles and Techniques. University of Cambridge, UK.
4. Eric, E. C., Paul K., Stum P.F., George, B. and Roy, H. D. 1995. Outlines of Biochemistry, John Wiley and Sons, Inc., Canada.
5. Palanivelu, S. and Shanmugavelu, S. 1993. Principles of Biochemistry and Biotechniques. Palani paramount publications, Madurai.
6. Prakash, M. and Arora, C.K. 1998. Laboratory Instrumentation, Anmol Publications Pvt. Ltd. New Delhi.

THIRD SEMESTER

FISH NUTRITION AND FEED TECHNOLOGY

Code: BFS 301
2L+1P=3
Credit-3

Full Marks - 100

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.

Recommended books:

1. Halver, J.E. 1989. Fish Nutrition, Academic Press, San Diego, CA.
2. NRC. Nutritional Requirements of Warm Water Fishes. National Academy of Sciences, Washington.
3. Lovell, R.T. 1998. Nutrition and feeding of fishes, Chapman & Hall, New York.
4. New, M.B. 1987. Feed and feeding of fish and shrimp. A manual on the preparation and preservation of compound feeds for shrimp and fish in aquaculture. F.A.O. Rome.
5. Sena S.De Silva, Trevor A.Anderson. 1995. Fish nutrition in aquaculture, Chapman & Hall Aquaculture Series, London.

CULTURE OF FISH FOOD ORGANISMS

Code: BFS 302
1L+1P=2
Credit-2

Full Marks - 100

Candidate species of phytoplankton and zoo-plankton as live 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, cladocerons, 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.

Recommended books:

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

INLAND FISHERIES

Code: BFS 303
2L+1P=3
Credit-3

Full Marks - 100

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

Recommended books:

1. Jhingran, V.G. 1991. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
2. FAO. 1999. Aquaculture Production Statistics 1988-'97.
3. Jayaram, K.C. 1999. The Freshwater Fishes of the Indian Region. Narendra Publication, New Delhi.
4. Munro, S.I. 1982. The Marine and Fresh Water Fishes of Ceylon. Soni Reprints Agency, New Delhi.
5. Silas, E.G. 1992. Fresh Water Prawns. Kerala Agricultural Univ., Kochi.

OCEANOGRAPHY

Code: BFS 304
2L+1P=3
Credit-3

Full Marks - 100

The earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: Definition and terms; classification Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. 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; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. 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.

Recommended books:

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

MARINE BIOLOGY

Code: BFS 305

Full Marks - 100

2L+1P=3

Credit-3

Introduction: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans – general account of major groups of phytoplankton, sea weeds, major zooplankton groups. Environmental factors affecting life in the oceans- salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. 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, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, nekton and benthos.

Recommended books:

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

REFRIGERATION AND FREEZING TECHNOLOGY

Code: BFS 306

Full Marks - 100

2L+1P=3

Credit-3

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, methods and systems. Refrigeration cycle, 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, hydraulic, pneumatic and electric. Bilge pumping systems. Deck and fish hold; Deck design: Deck design and layout. Anchors and mooring. Equipments commonly available in processing units. Different types of ice making machinery. Operation of various machinery used in freezing; canning and packaging. Special equipment for freeze-drying; irradiation and cryogenics; general maintenance of freezing plant, cold storage and ice plant.

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

Practical: Graphically represented symbols used in refrigeration, Calculation on thermodynamics, Handling and operation of refrigerants, compressors, condensers, evaporators and expansion valves. Defrosting in refrigeration system. Handling of low pressure and high pressure switches. Calculations on refrigeration effect and cooling estimate. Calculation on heat load, wall heat gain load and air change load. Studies on power transmission. Refrigeration machinery maintenance and safety precaution. Ice making and harvesting. Visit to a processing plant refrigeration unit. Conventional representation of common engineering component and features. Visit to fishing harbour to study about deck machinery and hull equipment. Operation and maintenance of ice making machinery, canning machinery, fish products machinery and packing machinery. Study on different types of gallows. Visit to a fish processing unit to study the equipment used in different types of processing.

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

Recommended books:

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

Statistical Methods in Fisheries

Code: BFS 307

1L+1P=2

Credit-2

Full Marks - 100

Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem, introduction to statistical inference, general principles of testing of hypothesis – types of errors. Tests of significance based on normal, t, 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.

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.

Recommended books:

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

FOURTH SEMESTER

AQUACULTURE ENGINEERING

Code: BFS 401
2L+1P=3
Credit-3

Full Marks - 100

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.

Recommended books:

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

ORNAMENTAL FISH PRODUCTION AND MANAGEMENT

Code: BFS 402
1L+1P=2
Credit-2

Full Marks - 100

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 ornamental fish diseases and prophylactic measures.

Recommended books:

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

COASTAL AQUACULTURE AND MARICULTURE

Code: BFS 403

Full Marks - 100

2L+1P=3

Credit-3

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.

Recommended books:

1. Bardach. 1972. Aquaculture, John Wiley and sons, New York.
2. Santhanam, R., Ranganathan, N. and Jagathesan, G. Coastal Aquaculture in India. CBS Publisher & Distributors, New Delhi.
3. Dash, M.L and Patnaik. P.N. 1994. Brackish Water Prawn Culture, Palani Paramount Publications, Palani.
4. Fast, A.W and Lester, L.J (Ed.). 1992. Marine Shrimp Culture- Principles and Practices. Elsevier Scientific Publishing Company. Amsterdan.
5. Oven, O.H. 1981. Aquaculture of Grey Mulletts, Cambridge University Press, Cambridge.
6. Thomos, P.C. 1998. Shrimp Seed Production and Farming, Casino Publications, New Delhi.
7. James P.SB.R. 1991. Manual on pearl culture techniques, C.M.F.R.I. bulletin no 39. Cochin.
8. Mc Vey. J.P. et al. 1993. CRC Hand Book of Mariculture. Vol.2. Crustacean Aquaculture. CRC Press. Boca Raton .USA

PHYSIOLOGY OF FINFISH AND SHELLFISH

Code: BFS 404
2L+1P=3
Credit-3

Full Marks - 100

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

Recommended books:

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

FISHING CRAFT AND GEAR TECHNOLOGY

Code: BFS 405
2L+2P=4
Credit-4

Full Marks - 100

Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication, dimension, nature of fishing, depth of operation etc. History & development of mechanization of fishing crafts: Boat building materials - 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: Drawing conventions in naval architecture. Form co-efficient & ratios: Design procedure: Displacement-weight equation; estimation of light weight ship; Basic mathematics & Hydrodynamics for designing of fishing vessels. Calculation of displacement, water plane area; Stability of fishing vessel – longitudinal, transverse. Various equilibrium of ships - stable, unstable and neutral. Resistance of boats. 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 – types, components. Different types of engine systems. Outboard engines working and maintenance. Estimation of engine power for fishing vessel. Marine propeller types, characters & selection of propellers. Boat construction methods: construction of wooden boats, steel boat, fiber glass boat, aluminum & ferro-cement boat. Deck-fittings and maintenance - common fouling & boring organisms. Preservation and maintenance of various types of hull. Stern gear assembly. Deck fitting and fishing equipment. Rules and regulations for fishing vessel fabrication, operation & safety.

Introduction: History and development of fishing gears; 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 - natural and synthetic - yarns, twines, ropes - their properties and identification methods. Yarn numbering systems 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 – different methods, hanging coefficient, take up ratio. Accessories for fishing gear. Floats – buyos – its materials, types, properties and buoyancy. Sinkers – types, materials, properties- negative buoyancy; bobbins, tickler chain. Wire ropes – wires, strands, cores – selection of wire ropes, breaking strength, specification. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, butterfly, chains. Hooks; types, materials, specification numbering system, jigs, spoon hooks. Maintenance and storage of gears and gear materials. Preservation of netting and other accessories. Selection of gear materials. Parts of a trawl net, purse seine, gill net and tuna long lines. FAO classification of fishing gear and methods. Modern commercial fishing methods- Operation and classification of trawling, purse seining, lampara net fishing, gill netting, line fishing. Squid jigging. Selective fishing – active fishing and passive fishing. Deck layout – trawlers, purse seiners, long liners, gill netters and combination fishing. Fishing accessories and deck equipments – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipments.

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.

Handling of net braiding tools, making different knots, bends, hitches, net braiding using different knots- shaping, creasing, baiting, fly mesh tailoring – T-cuts, N- cuts, B-cuts. Calculations- joining of netting, lacing, seaming. Mounting methods, hanging, revving, direct, indirect, connected calculations- assembling of netting. Damages on the netting, mending of net, identification of synthetic and natural fibres by various methods. Calculation of bouncy, negative buoyancy – identification of fibres, twines, ropes, iron wares, fish hook. Specification of ropes, wire ropes, iron wares, rigging materials, methods. Seining, boat seines, beach seines, gill netting, drift set, trammel nets. Line fishing – pole and line, tuna long lines, squid jigging. Falling gear - cast nets. Lift nets, Chinese dip nets. Deck layout of trawlers. Purse seiners, tuna long liners, gill netters and combination fishing vessels. Fishing experience in operation of traditional and modern fishing methods. Familiarization of various fishing accessories on board.

Recommended books:

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

CANNING AND FISH PACKAGING TECHNOLOGY

Code: BFS 406

Full Marks - 100

1L+1P=2

Credit-2

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 – meats, 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.

Recommended books:

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

EXTENSION EDUCATION IN FISHERIES

Code: BFS 407

Full Marks - 100

1L+1P=2

Credit-2

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co- management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extensions program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation.

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

Recommended books:

1. Pandey, S.K. 1997. Teaching Communication. Common Wealth Publishers, New Delhi.

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

FISHERIES ADMINISTRATION AND LEGISLATION

Code: BFS 408

Full Marks - 100

2L+0P=2

Credit-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.

Recommended books:

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

FIFTH SEMESTER

FINFISH BREEDING AND HATCHERY MANAGEMENT

Code: BFS 501

Full Marks - 100

2L+1P=3

Credit-3

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,, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warm water finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland

– its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Broodstock management and transportation of 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.

Recommended books:

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

SHELLFISH BREEDING AND HATCHERY MANAGEMENT

Code: BFS 502

Full Marks - 100

2L+1P=3

Credit-3

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 physiology. 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.

Recommended books:

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

DISEASES AND MANAGEMENT

Code: BFS 503

Full Marks - 100

2L+2P=4

Credit-4

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. Fish pharmacology – drugs, chemicals, antibiotics, probiotics and their mode of action.

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

Recommended books:

1. Kabata, Z. 1985. Parasites and Diseases of Fish Cultured in Tropics. Taylor & Francis, London.
2. Woo, P.T.K. (Ed). 2006. Fish Diseases and Disorders. Vol. I CAB International, Oxfordshire, U.K.
3. Roberts, R.J. (Ed). 2001. Fish Pathology (Third edition). W.B. Saunders, London.
4. Hoffman, G.L. and Meyer, F.P. 1974. Parasites of Freshwater Fishes. T.F.H. Publications, New Jersey.
5. Shaperclaus, W. 1991. Fish Diseases. Vol. I & II. Oxonian Press Pvt. Ltd., New Delhi.
6. Sinderman, C.J. 1970. Principal Diseases of Marine fish and Shellfish. Academic Press, New York.

MARINE FISHERIES

Code: BFS 504
2L+1P=3
Credit-3

Full Marks - 100

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

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

Recommended books:

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

AQUATIC ECOLOGY AND BIODIVERSITY

Code: BFS 505
2L+1P=3
Credit-3

Full Marks - 100

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. The sea shore: The Inertial Zone, factors Affecting life on shore, nature of substratum, physical factors, zonation, fauna and flora on a rocky shores, sandy shore, and muddy shore. Conservation of habitats: endangered species and their conservation, fish passes for migratory fishes, protected areas, marine parks and sanctuaries, 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 Fouler organisms, assessment of the damages and appraisal of remedial measures. Visit to a marine park/sanctuary. Understanding the steps involved in protecting endangered habitats and species (Horse shoe crab, Marine turtles, sharks and marine mammals).

Recommended books:

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

NAVIGATION AND SEAMANSHIP

Code: BFS 506

1L+1P=2

Credit-2

Full Marks - 100

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 - radar, sonar, decca, omega, loran etc; 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.

Recommended books:

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

DISASTER MANAGEMENT IN FISHERIES

Code: BFS 507

Full Marks - 100

1L+1P=2

Credit-2

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and impact of various disasters. Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices. Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global level. Sea safety and health.

Practical: Methods for assessment of initial and long term damages. Preparedness in pre, during and post disasters. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Operation and usage of communication channels and media. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counseling. Field visits and case studies. Group discussion.

Recommended books:

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

SIXTH SEMESTER

BIOTECHNOLOGY & BIOINFORMATICS

Code: BFS 601
1L+1P=2
Credit-2

Full Marks - 100

DNA as genetic material, Chemistry of nucleic acids, Genetic code. Organization of genome in prokaryotes and eukaryotes. Concept of replication, transcription and translation. Recombinant DNA technology, Gene cloning and Transgenesis, Molecular and immunological techniques, Cell culture and cell lines, Development of vaccines, Hybridoma technology, Monoclonal antibody production, PCR techniques, Marine biotechnology – bioactive compounds from marine organisms, Waste water treatment, Biofilters in aquaculture, Biofertilizers, Probiotics, Biosensors, Bioprocessing. Concept of Bioinformatics - NCBI, Genebank sequence database-primary and secondary database.

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

Recommended books:

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

FISHERY GENETICS AND BREEDING

Code: BFS 602
1L+1P=2
Credit-2

Full Marks - 100

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance, Gene interactions – Epistasis, Pleiotropism, Dominance, Lethal genes. Sex determination, Sex linked genes, sex influenced and sex limited traits. Hybridization. Mutation, Chromosomal structure and aberrations. Linkage and crossing over. Chromosome manipulation techniques. Cryopreservation. Introduction to population genetics. Hardy-Weinberg law and its significance. Quantitative genetics – qualitative and quantitative traits, polygenic traits, heritability. Inbreeding and its consequences. History and present status of selective breeding programs in aquaculture. Selection methods and breeding plans. Mating designs. Domestication methods. Seed certification and quarantine procedures.

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

Recommended books:

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

FISH POPULATION DYNAMICS AND STOCK ASSESSMENT

Code: BFS 603

Full Marks - 100

1L+1P=2

Credit-2

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Carlo simulation model and ECCPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

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

Recommended books:

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

AQUATIC POLLUTION AND COASTAL ZONE MANAGEMENT

Code: BFS 604

Full Marks - 100

2L+1P=3

Credit-3

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; 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. Anthropogenic activities and their impact on coastal zones; 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. Integrated Coastal Zone Management (ICZM). International treaties and conventions. Preparation of projects based on the provided Guidelines and Standards for Coastal Projects- aquaculture, agriculture, estuarine flood protection, sewage treatment systems, solid waste disposal, Urban run off, Power plants, disasters, etc.

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

Recommended books:

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

FISH PRODUCTS AND BYPRODUCTS TECHNOLOGY

Code: BFS 605

Full Marks - 100

2L+1P=3

Credit-3

Principle of fish preservation and processing. Processing of fish by traditional methods – salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting –wet salting and dry salting. Drying and dehydration- theory, importance of water activity in relation to microbial growth .Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish. Fish preservation by smoking-

chemical composition of wood smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle technology in fish preservation and processing. Marinaded and fermented fish products – role of acids in marinades, 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 salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of fish manure, fishmeal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin and chitosan. Quality assessment of individual by-products. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinaded products. Preparation of surimi and surimi based products. Preparation of seaweed products, Preparation of diversified and value added fish products.

Recommended books:

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

FISH MICROBIOLOGY AND QUALITY ASSURANCE

Code: BFS 606

Full Marks - 100

2L+2P=4

Credit-4

Introduction and 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. Psychrophiles, halophiles and thermophiles, their role in spoilage and food poisoning. Food borne human pathogens - Vibrio, E coli, Salmonella, Listeria, Clostridia, Campylobacter, Streptococcus, Faecal Streptococcus, etc. Study of micro-organisms in food by conventional and rapid techniques. Encapsulation – endospores, formation of cell aggregates, Microbial principles of fish preservation and processing. 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. CIP, Water management in fish processing industries.

Practical: Study of micro-organisms associated with finfish and shellfish. Spoilage micro-organisms. Isolation of pathogenic bacteria associated with fish and fishery products - Vibrio, E coli, Salmonella, Listeria, Clostridia, Campylobacter, Streptococcus, Faecal Streptococcus, etc. Effect of chemical and physical preservatives on spoilage organisms. Conventional and rapid methods for detection of

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

Recommended books:

1. Connell, J.J. 1980. Control of Fish Quality. Springer – Verlag, NewYork.
2. Huss, H.H., et al.1992. Quality Assurance in the Fish Industry. Elsever Science Publishers, B.V., Amsterdam, Netherlands.
3. Jeyasekharan, G., Jaya Shakila, R. and Sukumar, D. 2006. Quality and Safety of Sea foods – Text Book, Tamilnadu Veterinary and Animal Sciences University, Chennai.
4. Surendran, P.K., Nirmala thampuran, Narayanan Nambiar, V. and Lalitha, K.V. 2003. Laboratory Manual on Microbiological Examination of Sea food, CIFT, Cochin.
5. Quality Assurance in sea food Processing. 2005. Published by CIFT, Cochin.
6. Burgess, et al. 1982. Fish Inspection and Quality Control. Fishing News Books Ltd England.
7. Bonell, A.O. 1994. Quality Assurance in Seafood Processing: A practical Guide. Chapman and Hall, New York.
8. Huss, H.H. 1994. Assurance of Seafood Quality. FAO Fisheries Technical Paper 334, FAO, Rome, Italy

FINANCING AND MARKETING MANAGEMENT IN FISHERIES

Code: BFS 607

Full Marks - 100

2L+2P=4

Credit-4

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 equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products.

Recommended books:

1. Chaston, I. 1987. Marketing in Fisheries and Aquaculture. Fishing News Books, England.
2. Sathaidhas, R. 1997. Production & Marketing Management of Marine Fisheries in India. Daya Publishing House, Delhi.

3. Kotler, Philip. 1995. Principles of Marketing. Prentice-Hall of India, New Delhi.

ENTREPRENEURSHIP DEVELOPMENT AND COMMUNICATION SKILLS

Code: BFS 608

Full Marks - 100

1L+1P=2

Credit-2

Entrepreneurship Development: 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; SWOT analysis, 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 fisheries inputs industry. Characteristics of Indian fisheries processing and export industry. Social Responsibility of Business. Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical: 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.

Recommended books:

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

SEVENTH SEMESTER

Hands-on Training in Fisheries (Experiential Learning)

Code: BFS 701

Full Marks - 100

OL+20P=20

Credit-20

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 20 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.

Areas of specialization for "Hands-on Training: College may consider having not more than two such programs for experiential learning. This may be offered either in VII or VIII semester, considering the seasonality in fisheries activities.

Sl	Ornamental fish culture	Credits
1	Preparation of work plan	3
	World trade, export potential, exogenous and indigenous species, aquarium keeping	
2	Varieties of ornamental fishes	3
	Studies on traits of different varieties of ornamental fishes	
	Collection and identification of native species	
3	Fabrication and maintenance of aquaria	3
	Fabrication, Setting up and maintenance of aquaria	
	Water quality management	
4	Accessories	1
	Types of filters, aerators, and decoratives; aquarium plants and their propagation	
5	Feeding	2
	Feeds and feeding, Culture of live feed	
6	Breeding and health management	3
	Breeding of live bearers, barbs, goldfish, tetras, chichlids, gauramis, fighters and catfishes	
	Broodstock management	
	Diseases and their control	
7	Marketing	2
	Packing and transportation, health certification, Pricing, and marketing	
8	Documentation and report	2
	Book keeping, resource management, preparation of final report	
7	Oral examination	1
	Presentation, Oral performance	

	Total	20
II	Seed Production in Fisheries	
1	Preparation of work plan	3
	Target seed production, broodstock requirement, Infrastructure facility, Inputs, Supplies and marketing	
2	Species and site selection	2
	Species selection	
	Site selection	
3	Hatchery	4
	Layout plan, design, construction / fabrication, operational management	
	Broodstock management, live food production	
4	Breeding	4
	Selection of brooders, acclimatization, induced breeding, collection and estimation of eggs and spawn, packing and transportation.	
5	Nursery and Rearing pond management	4
	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	20
III	Trade and Export Management in Fisheries	
1	Preparation of project plan	3
	Learning to buy, product selection, procurement, project formulation, preparation of plans. Registration procedures	
2	Marketing	4
	Marketing research (products, markets)	
	Supply chain management	
3	Export and import management	5
	Export and import procedures, documentation, licensing, inspection, export schemes. Pre-shipment and post-shipment finance.	
4	Seafood regulations	2
	Import regulations in US, Japan and EU. Domestic regulations	
5	Mock export	3
	Industry attachment, Compliance to different regulations, clearing and forwarding (C&F)	
6	Documentation and reports	2
	Book keeping, Human Resource management, Preparation of manual and final report	
7	Oral examination	1
	Presentation, Oral performance	
	Total	20

IV	Aqua-Clinic	
1	Preparation of project plan Project Formulation, Finance Mobilisation, Business Management	3
2	Soil and Water Testing Instrumentation. Weather Conditions, Temperature, pH, Turbidity, Salinity, Dissolved Oxygen, Carbon Dioxide, Alakalinity, Hardness, Ammonia, Nitrites Nitrates, Phosphates, Iron, BOD, Plankton Analysis, Water Management and Bio-remediation Soil Texture and Structure, Available Nitrogen, Available Phosphorus, Organic Carbon	5
3	Disease Diagnosis Microscopy, Case History, Sample Collection, Clinical Examination, Postmortem Examination, Sample Preservation, Sterilization Techniques, Bio-chemical Test for Bacterial Identification, Histo- pathological Techniques, Immunological Techniques, Dot Blot Test, PCR Test, Aqua Medicines in the market and Banned Antibiotics, Dose Calculation, Treatment Schedule and Drug Administration. Quarantine and certification	6
4	Feed Analysis Preliminary Examination (History, Colour, Odour, Texture), Estimation (Moisture, Ash, Crude Protein, Calcium, Phosphorus, Nitrogen Free Extracts, Total lipids, Water Stability), Knowledge on Proximate composition of Branded Feeds available in the market, Recommendation (Feed Quantity and Schedule), Quality assessment and certification.	3
5	Advisory Services Farm design, water quality, seed quality, feed formulation, information services, etc	
6	Documentation and reports Book keeping, Human Resource management, Preparation of final report	2
7	Oral examination Presentation, Oral performance	1
	Total	20
V	Post Harvest technology	
1	Preparation of project plan Project Formulation, Finance Mobilisation patterns, Business Management	3
2	Preparation of ready to eat value added products Selection of viable product, Selection of raw material, Recipe standardization, Preparation of products, Packaging and marketing	5
3	Cured products preparation and marketing Selection of viable method of drying, Raw material procuring, Development of dried products, Packaging & marketing	4
4	Fresh fish marketing Fresh fish dressing, packing, transportation, marketing, cold chain / Live fish marketing	

5	Food safety and Quality assurance	5
	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	20
VI	Aqua farming	
1	Preparation of Project Plan	3
	World trade, domestic trade, export potential, project formulation, Finance mobilization, Business management	
2	Suitable Varieties of Fish / Prawn	1
	Studies on traits of different varieties of cultivable fish and shellfish, collection and identification of indigenous & exotic, species, types of farming.	
3	Farm Design and Construction	1
	Site selection, Design and construction of ponds, reservoir and Effluent treatment system.	
4	Pond Preparation	2
	Eradication of predator and weed fishes, eradication of aquatic weeds, pond sterilization, sun drying, ploughing, leveling and liming / gypsum treatment of pond bottom, water filling, fertilization.	
5	Seed Stocking	1
	Tests for selection of good quality seed, source & transport of seed, stocking time and density, size of stocking, acclimatization, estimation of survival rate (using survival nets)	
6	Pond management	8
	Stock manipulation and management, production & maintenance of natural food, supplementary feeding-common feeds used, feeding schedule, soil and water quality management- Estimation of various soil & water quality parameters for sustainable culture, trouble indicators and health management, chemicals, antibiotics and probiotics used.. Use of aerators, sampling for estimation of feed requirement, growth and health condition.	
7	Harvesting and marketing	1
	Days of culture, time of harvest, methods followed, precautions considered to maintain quality of product, Methods of packing and transport, market outlets, International quality standards for farmed products, cost- benefit analysis.	
8	Documentation and Report	2
	Book keeping, resource management, preparation of final report	
9	Oral Examination	1
	Presentation, Oral performance	
	Total	20

EIGHTH SEMESTER

IN-PLANT TRAINING IN FISHERIES

Code: BFS 801

0L+20P=20

Credit-20

Full Marks - 100

The suggested duration for this program is 17 weeks, with initial one week for orientation, 14 weeks for industry attachment and last two weeks for report writing. This may be offered either in VII or VIII semester, considering the seasonality in fisheries activities.

One academic staff member of the college need to co-ordinate and monitor the entire "In- plant training" program. Each student or a batch of students shall be sent to the aqua farm, hatchery, ornamental fish culture unit, processing plant, product development unit or export agency – whichever is accessible to the college. Those colleges, which could not identify a suitable private firm for In-plant training program, may approach the Central Institute of Fisheries Education, Mumbai or any fisheries institutes under ICAR for making suitable arrangements. The evaluation of the program shall be done by the host industry (50%) and one academic staff member of the college (50%) to be nominated by the Dean / Associate Dean of the college.