VIDYASAGAR UNIVERSITY

Curriculum for 3-Year BSc (HONOURS)
In

AQUACULTURE MANAGEMENT

Under Choice Based Credit System (CBCS)
w.e.f 2017-2018

VIDYASAGAR UNIVERSITY

B Sc (Honours) in Aquaculture Management

[Choice Based Credit System]

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
							CA	ESE	TOTAL
	Semester-I								
1	I	Core-1		CT1: Taxonomy, Anatomy & Biology of Fin Fishes and Shell Fishes	6	4-0-0	15	60	75
				CP1: Practical		0-0-4			
		Core-2		CT2: Capture Fisheries	6	4-0-0	15	60	75
				CP2: Practical		0-0-4			
		GE-1		TBD	6	4/5	15	60	75
						2/1			
		AECC-1		English/MIL	2	1-1-0	10	40	50
	Semester –I: total				**20**				**275**
	Semester-II								
	II	Core-3		CT3: Aquaculture Practices	6	4-0-0	15	60	75
				CP3: Practical		0-0-4			
		Core-4		CT4: Genetics & Reproduction in fish	6	4-0-0	15	60	75
				CP4: Practical		0-0-4			
		GE-2		TBD	6	4/5	15	60	75
						2/1			
		AECC-2		ENVS	4		20	80	100
	Semester-II : total				**22**				**325**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
							CA	ESE	TOTAL
	Semester-III								
2	**III**	Core-5		CT5: Fisheries Statistics, Economics And Marketing Management	6	4-0-0	15	60	75
				CP5: Practical		0-0-4			
		Core-6		CT6: Aquatic Ecology, Pollution And Biodiversity	6	4-0-0	15	60	75
				CP6: Practical		0-0-4			
		Core-7		CT7: Aquatic Microbiology, Fisheries Biotechnology And Bioinformatics	6	4-0-0	15	60	75
				CP7: Practical		0-0-4			
		GE-3		TBD	6	4/5	15	60	75
						2/1			
		SEC-1		SEC1P:Ornamental Fish Production and Aquarium Management	2	0-0-4	10	40	50
		Semester – III : total			**26**				**350**
	Semester-IV								
	IV	Core-8		CT8:Fundamentals Of Biochemistry, Fish Nutrition And Feed Technology	6	4-0-0	15	60	75
				CP8: Practical		0-0-4			
		Core-9		CT9:Fisheries Extension, Cooperative and computer Application	6	4-0-0	15	60	75
				CP9: Practical		0-0-4			
		Core-10		CT10:Marine Fisheries, Oceanography and Coastal Aquaculture	6	4-0-0	15	60	75
				CP10: Practical		0-0-4			
		GE-4		TBD	6	4/5	15	60	75
						2/1			
		SEC-2		SEC2P:Fish Breeding and Hatchery Management of Carp/Catfish/ Prawn	2	0-0-4	10	40	50
		Semester – IV : total			**26**				**350**
Year	**Semes**	**Course**	**Course**	**Course Title**	**Credit**	**L-T-P**	**Marks**		

	ter	Type	Code				CA	ESE	TOTAL
		Semester-V							
3	**V**	Core-11		CT11: Fishing Crafts, Gears And Fishing Technology	6	4-0-0	15	60	75
				CP11: Practical		0-0-4			
		Core-12		CT12: Post Harvest Technology, Fish And Aquaculture Products And Bi-Products	6	4-0-0	15	60	75
				CP12 : Practical		0-0-4			
		DSE-1		DSE1T:Fisheries Biotechnology, Bioinformatics and Statistics	6	4-0-0	15	60	75
				DSE1P:Practical		0-0-4			
		DSE-2		DSE2T:Post-Harvest Technology and Quality Assurance of Fishery Products	6	4-0-0	15	60	75
				DSE2P:Practical		0-0-4			
		Semester –V : total			**24**				**300**
		Semester-VI							
	VI	Core-13		CT13: Fish Disease, Immunity And Health Management	6	4-0-0	15	60	75
				CP13: Practical		0-0-4			
		Core-14		CT14: Population Dynamics And Stock Assessment And Therapeutics In Aquaculture	6	4-0-0	15	60	75
				CP14: Practical		0-0-4			
		DSE-3		DSE3T:Fisheries Economics , Fisheries Policy and Laws and Entrepreneurship Development	6	4-0-4	15	60	75
				DSE3P:Practical		0-0-4			
		DSE-4		Training / Project Work	6	0-0-12	15	60	75
		Semester – VI : total			**24**				**300**
Total in all semester:					**142**				**1900**

CC = Core Course , **AECC** = Ability Enhancement Compulsory Course , **GE** = Generic Elective , **SEC** = Skill Enhancement Course , **DSE** = Discipline Specific Elective , **CA**= Continuous Assessment , **ESE**= End Semester Examination , **TBD**=To be decided , **CT** = Core Theory, **CP**=Core Practical , **L** = Lecture, **T** = Tutorial ,**P** = Practical , **MI**L = Modern Indian Language , **ENV**S = Environmental Studies ,

List of the Core Courses (CC)

CC-1: Taxonomy, Anatomy & Biology Of Fin Fishes and Shell Fishes
CC-2: Capture Fisheries
CC-3: Aquaculture Practices
CC-4: Genetics & Reproduction in fish
CC-5: Fisheries Statistics, Economics and Marketing Management
CC-6: Aquatic Ecology, Pollution and Biodiversity
CC-7: Aquatic Microbiology, Fisheries Biotechnology and Bioinformatics
CC-8: Fundamentals of Biochemistry, Fish Nutrition and Feed Technology
CC-9: Fisheries Extension, Cooperative and computer application
CC-10: Marine Fisheries, Oceanography and Coastal Aquaculture
CC-11: Fishing Crafts, Gears and Fishing Technology
CC-12: Post Harvest Technology, Fish and Aquaculture Products and Bi-Products
CC-13: Fish Disease, Immunity and Health Management
CC-14: Population Dynamics and Stock Assessment and Therapeutics in Aquaculture

Discipline Specific Electives (DSE)

DSE-1: Fisheries Biotechnology, Bioinformatics and Statistics
DSE-2: Post-Harvest Technology and Quality Assurance of Fishery Products
DSE-3: Fisheries Economics , Fisheries Policy and Laws and Entrepreneurship Development
DSE-4: Training / Project Work

Skill Enhancement Course (SEC)

SEC-1: Ornamental Fish Production and Aquarium Management
SEC-2: Fish Breeding and Hatchery Management of Carp/Catfish/ Prawn

Generic Electives (GE)

GE-1: Fundamentals of Fisheries & Aquaculture
GE-2 : Inland fisheries resources, fish breeding and seed production
GE-3 : Marine fisheries and oceanography
GE-4 : Fish and Aquaculture Products and By-Products for Health and Nutrition

Core Courses

CC-1 : Taxonomy, Anatomy & Biology of Fin fishes and Shell fishes

Credits 06

C1 T: Taxonomy, Anatomy & Biology of Fin fishes and Shell fishes

(Theory) **Credits: 04**

1. **Taxonomy of Finfishes and Shellfishes**: Principles of taxonomy, Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Method employed in phylogenic studies. Phylogenic tree. Fish identification and fish bar-coding. Major taxa of inland and marine fishes (up to order level). Commercially important fishes of the World. Study of external morphology and classification (up to Sub-class) of Crustacea, Bivalvia, Gastropoda and Cephalopoda.

2. **Anatomy of Finfishes and Shellfishes**: Study of internal anatomy of shell fishes and fin fishes having commercial importance. Study of the oral region and associated structures, (teeth, gill rakers, buccopharyngial region, digestive tract), Associated digestive glands (liver, pancreas, gall bladder). Circulatory system, respiratory system, nervous system and urino-genital system/reproductive system of fishes and shellfishes. Osteology of fishes.

3. **Biology of Finfishes and Shellfishes**: Study of food and feeding habits of commercially important fin fishes and shell fishes. Age and growth of commercially important fin fishes and shell fishes. Marking and tagging; Length-weight relationship, respiration, digestion, excretion, osmoregulation and reproductive physiology. Reproductive biology – maturity stages, gonado-somatic index, sex ratio, spawning and fecundity. Eggs and larval stages and developmental biology of finfishes and shellfishes.

C1 P: Taxonomy, Anatomy & Biology of Fin fishes and Shell fishes

(Practical) **Credits: 02**

1. Collection, preservation and taxonomic study of commercially important Inland and marine finfishes and shellfishes (prawns, crab, lobsters, bivalves, gastropods, cephalopods, echinoderms etc).
2. Study of morphometric and meristic characteristics of collected fishes (finfishes & shellfishes), Study of types of fish scales.
3. Dissection of different finfishes & shellfishes to understand the internal organization of organs
4. Preparation of endoskeleton
5. Analysis of fish gut contents, Study of food and feeding habits of finfishes and shellfishes

6. Classification of maturity stages, estimation of fecundity, identification of eggs and larval stages, study of embryonic and larval development of commercially important finfishes and shellfishes.
7. Tagging and Marking

CC-2 : Capture Fisheries **Credits 06**

C2 T: Capture Fisheries

(Theory) **Credits: 4**

1. **Inland Capture Fisheries**: Freshwater fishery regions of the world and their major fisheries, species composition, Global inland fish production statistics. Inland fishery resources of India, Present scenario of inland capture fisheries of India, their potential, problems. Trend of inland capture fish production, Major riverine and estuarine fisheries of India. Fisheries of major rivers/reservoirs/lakes of India. Coldwater fisheries of India.

2. **Marine Capture Fisheries**: Overview of marine fishery resources of the world and India. Classification and definition of fishery zones, offshore and deep sea fisheries of India. The major important fin fish and shell fish resources and their economic management. Major pelagic and demersal fisheries of India. Crafts and gears operated in Indian marine water. Marine fisheries development in India. The concept of total catch and catch per unit effort. Remote sensing potential marine fishing zones (PFZ), EEZ. Conservation of marine fishery resources.

C2 P: Capture Fisheries **(Practical)**

Credits: 02

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

2. Study of external morphology, collection, preservation and identifications of prawns, crabs, lobsters, bivalves, gastropods, cephalopods, echinoderms from natural habitats.

3. Observations and experimental operations of selected fishing gears in marine water of India, Maintenance of records on catch statistics and observations.

4. Visit to a fish landing centers, observation and analysis of catches by major craft and gears.

5. Field collection of samples of fishes, crustaceans and molluscs, and their analysis for biological characteristics. Participations in fishing trips and research

CC-3 : Aquaculture Practices **Credits 06**

C3 T: Aquaculture Practices **Credits 04**

(Theory)

1. **Freshwater Aquaculture**: Different freshwater aquaculture systems. Preparation and management of nursery and rearing ponds. Control of aquatic weeds and algal blooms. Monoculture and polyculture of carps, stocking density and ratio, supplementary feeding. Criteria for selection of candidate species for aquaculture. Technology of semi-intensive, intensive and super intensive systems of aquaculture. Aquaculture in running water system, re-circulatory system, cages and pens. Air-breathing fish culture. Culture of coldwater fishes. Culture of freshwater prawns. Definition, history and scope of integrated aquaculture. Principles of organic recycling and detritus food chain. Integration of crop, livestock and fish farming as complimentary activities. Wastewater aquaculture and Paddy-cum fish culture.
2. **Mariculture**: Resource of marine species for shore-based aquaculture and sea farming in India. Cultivable traits of important candidate species of fish and shelfish with notes on their biology (Sea bass, Mullets, Milkfish, Groupers, Tiger shrimp, Mud crab, Mussels, Clams, Oysters etc.). Shore-based aquaculture systems: traditional (Pokkali, Bheries), semi-intensive aquaculture practices of commercially important species. Management of marine fisheries.
3. **Ornamental Fish Culture:** Ornamental fish culture as hobby. Setting up of freshwater and marine aquaria. Selection of suitable species, species combination. Use of natural and artificial aquatic plants and decorative toys. Use of biological filters, aerators, heaters etc. Commercial breeding and culture of ornamental fishes. Methods of production of live and artificial feeds. Common diseases of ornamental fishes and their control. Transport of live ornamental fishes and Aquascaping.

C3 P: Aquaculture Practices (Practical) **Credits: 02**

1. Study of cultivable species of fin fishes and shellfishes. Collection and study of predatory fishes, weed fishes. Collection and study of aquatic weed and aquatic insects from fish ponds.
2. Practical experience in the preparation and management of nursery, rearing and stocking tanks. Study of effect of liming, manuring and fertilization of fish ponds and on growth of fishes.
3. Methods of isolation and identification of different live feed organisms. Laboratory scale culture (batch and continuous) of selected live feed organism. Evaluation of live feed organisms. Mass culture of live fish food organisms. Study of algal blooms and their control. Effect of supplementary food on the growth of fishes.

4. Identification of common ornamental fishes and plants. Setting and maintenance of aquaria. Designs and construction of indoor aquaria. Identification of fish diseases and prophylactic measures. Culture of ornamental fishes. Transport of live ornamental fishes.

CC-4 : Genetics & Reproduction in fish **Credits 06**

C4 T: Genetics & Reproduction in fish (Theory) **Credits:04**

1. **Fish Genetics and Biotechnology:** Principles of genetics; Concepts of biotechnology. Genes and chromosomes, gene interaction. Linkage and crossing over. Chromosome maps, sex determination, chromosomal aberrations. Gene mutation; genome manipulation: gynogenesis, androgenesis, polyploidy. Transgenic fish, Sex-reversal, inbreeding & hybridization.

2. **Fish Endocrinology and Reproductive Biology:** Modes of reproduction. Secondary sexual characters and maturation process. Different endocrine glands. Ecological and hormonal influence on maturation and spawning; Breeding behavior; Pheromones in fishes. Gametogenesis, Fertilization, Cleavage, Gastrulation, Organogenesis.

3. **Breeding and Hatchery Management:** Natural breeding and seed production of fishes. Significance of propagation, sexual maturity, season of reproduction, place of propagation, parental care. Types of fish eggs and mechanism of hatching. Riverine spawn collection site, gears used for collection, methods of spawn collection, behavior of spawn in relation to hydrological and hydro-biological factors. Technology of seed production in warm water fishes; brood stock management, techniques of inducing ovulation. Multiple carp spawning. Chinese technique using spawning pool and incubation/hatching pools. Cryopreservation of fish gamete. Breeding technique for Indian major caps and other exotic carps.

C4 P: Genetics & Reproduction in fish (Practical) **Credits: 02**

1. Selection of breeders of carps and catfishes. Collection and preservation of pituitary glands in fishes.

2. Preparation and administration of pituitary gland extract. Use of synthetic compounds for induced breeding of fishes. Study of hatchery technology of fishes. Care of eggs, spawn and fry. Identification of eggs and larvae of common cultivable fishes.

3. Detailed study of design and operation of Chinese circular hatchery and funnel shaped hatchery. Study of seed production technology of Indian carps/Cat fishes, Tilapia.

4. Methods of isolation and culture of bacteria and fungus. Identification methods of common bacterial and fungal pathogens of fish.

CC-5: Fisheries Statistics, Economics and Marketing management

Credits 06

C5T: Fisheries Statistics, Economics and Marketing management (Theory)

Credits:04

1. **Fisheries Statistics**: Definition of sample, population in biometry: Frequency distribution, histogram, bar diagram, pie diagram. Measures of central tendencies (Mean, Median and Mode), Dispersion (SD, SE and Variance). Chi squire (X^2) test and Student's t-test. Regression analysis and ANOVA test.

2. **Fisheries Economics:**Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost factors of production, marginal cost and return, law of diminishing marginal return, returns toscale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost.

3. **Marketing Management:**Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, 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.

C5 P: Fisheries Statistics, Economics and Marketing Management(practical)

Credits: 02

1. Draw a histogram, bar diagram, pie diagram, chart etc
2. Collection of data and presentation of data. Testing of Goodness of fit; Chi squire (X^2)test and Student's t-test.
3. Developing questionnaire and conducting market surveys, analysis of primary andsecondary data.
4. Exercises on equilibrium price for fish and fishery products; estimation ofdemand and supply using simple regression.
5. Analysis of credit schemes of banks and thegovernment. Case studies of cooperatives.
6. Visit to co-operative societies, commercial banks andfish markets and organizations dealing with marketing of fish and fishery products.

CC-6 : AQUATIC ECOLOGY, POLLUTION AND BIODIVERSITY Credits 06

C6 T: AQUATIC ECOLOGY, POLLUTION AND BIODIVERSITY
(Theory) **Credits 04**

1. **Aquatic ecology:** Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains,coastal wet lands, bheels, oxbow lakes.
2. **Aquatic pollution:** Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and theirimpacts in the aquatic organisms and the abiotic environment, Classification of pollutionphysical,chemical and biological classification of water pollution-description ofterminologies. Sewage and domestic wastes- composition and pollution effects-sewagetreatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects ofoxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD, eutrophication. Different types of aquatic pollution and ther impact on aquatic biota.
3. **Biodiversity:**Definition, concept and types of biodiversity. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries.

C6 P: AQUATIC ECOLOGY, POLLUTION AND BIODIVERSITY
(Practical) **Credits: 2**

1. Collection of species of fishes and other organisms and studying the assemblages oforganisms of rocky, sandy and muddy shores, lentic and lotic habitats.

2. Observation of adaptivecharacters and interrelationships like commensalisms, symbiosis, parasitism and predation.

3. 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.

4. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.

5. Working out biodiversity indices.

CC-7: AQUATIC MICROBIOLOGY, FISHERIES BIOTECHNOLOGY AND BIOINFORMATICS **Credits 06**

C7T:AQUATIC MICROBIOLOGY, FISHERIES BIOTECHNOLOGY AND BIOINFORMATICS(Theory) **Credits: 04**

1. **Aquatic Microbiology:** Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses; distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators.

2. **Fisheries Biotechnology:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors.

3. **Bioinformatics**: Introduction to Bioinformatics; Biological Databases and tools : Introduction;Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents;Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS,Molecular visualization Sequence analysis.

C7P: AQUATIC MICROBIOLOGY, FISHERIES BIOTECHNOLOGY AND BIOINFORMATICS (Practical) **Credits: 02**

1. Collection of water and sediment samples for microbiological analysis Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems.

2. Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform.
3. Study of structure of prokaryot and Eukaoryt Cells. Study on Model of proteinSynthesis, Study of models rDNATechnology, Cell Culture

4. Isolation of Nucleic Acids, Restrictionenzymes, Gel Electrophorus, ELISA, DNAsequence analysis and comparison.

CC-8: FUNDAMENTALS OF BIOCHEMISTRY, FISH NUTRITION AND FEED TECHNOLOGY Credits 06

C8T: FUNDAMENTALS OF BIOCHEMISTRY, FISH NUTRITION AND FEED TECHNOLOGY (Theory) Credits: 04

1. **Fundamentals of Biochemistry:** Classification of carbohydrates. Structure and properties of maltose, lactose, sucrose, starch, glycogen and pectin. Classification and general structures of amino acids, properties due to carboxyl and amino groups of amino acids. Secondary, tertiary and Quaternary structures of proteins. Classification of lipids. Structures of palmitic acid, stearic acid, oleic acid, linoleic acid, arachidonic acid, lecithin and cephalin.Composition and metabolism, autoxidation and antioxidants, changes during processing and storage, rancidity, indices of rancidity. Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones-chemistry and function.

2. **Fish Nutrition:**Natural and artificial feeds. Nutritional requirements of cultivable fishesand prawns. Digestion, assimilation and conversion of feed. Nutritional bioenergetics of fish. Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Feeding devices and methods. Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutrional deficiency diseases.

3. **Feed Technology:** Methods of feed formulation and manufacturing. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage: use of preservatives and antioxidants. Feed evaluation: feed convertion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value.

C8 P: FUNDAMENTALS OF BIOCHEMISTRY, FISH NUTRITION AND FEED TECHNOLOGY (Practical) Credits: 02

1. Preparation of normal solution of acid and base, buffers and reagents.
2. Qualitativedetermination of carbohydrates, proteins and lipids. Estimation of total nitrogen and crude proteinof fish tissue.
3. Estimation of carbohydrates in foods. Determination of specific gravity of oil. Extraction and estimation of total lipids in fish tissue.
4. Proximate composition analysis of feed ingredients and feeds. Preparation of artificialfeeds using locally available feed ingredients.
5. Determination of sinking rate and stability of feeds.Effect of storage on feed quality.

CC-9 : FISHERIES EXTENSION, COOPERATIVE AND COMPUTER APPLICATION

Credits 06

C9 T: FISHERIES EXTENSION, COOPERATIVE AND COMPUTER APPLICATION (Theory)

Credits: 04

1. **Fisheries Extension:** Introduction to fisheries extension - concepts, objectives and principles of extension. History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extension program planning and evaluation - steps and importance; participatory planning process.

2. **Fishery Co-operatives**: 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.

3. **Computer Application:**Fundamentals computer; 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.

C9P: FISHERIES EXTENSION, COOPERATIVE AND COMPUTER APPLICATION (Practical)

Credits: 02

1. Collection of socio-economic data from fishing villages; study of socialissues/problems through participatory and rapid rural appraisal techniques, stake holders analysisand needs assessment; assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis
2. Case studies on extension programs and Success stories. Practicalexercises on conducting fish farmers meet.
3. Analysis of credit schemes of banks and the government.
4. Web Browsing, Creation and operation of Email account

5. Analysis of fisheries data using MS Excel.
6. Planning,preparation, presentation of posters, charts, overhead transparencies and slides.

CC-10:MARINE FISHERIES, OCEANOGRAPHY AND COASTAL AQUACULTURE

Credits 06

C10T:MARINE FISHERIES, OCEANOGRAPHY AND COASTAL AQUACULTURE)

(Theory) **Credits: 04**

1. **Marine Fisheries:**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.

2. **Oceanography:**Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction.

3. **Coastal Aquaculture:**An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, Seed resources.

C10P: MARINE FISHERIES, OCEANOGRAPHY ANDCOASTAL AQUACULTURE)

(Practical) **Credits: 02**

1. Identification of ecologically sensitive areas and protection, Study of CRZ, ICZM along the coastal belt, Study on implementation and violation of CRZ.
2. Study of application of remote sensing and GIS.
3. Observation and analysis of catches by major crafts and gears operated in marine water.
4. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data.
5. Identification of important cultivable species. Collection and identification of commercially important seed of fish and shellfishes.

6. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming.
7. Estimation of feed intake. Fouling organisms in cages and pens of coastal water.

CC-11: FISHING CRAFTS, GEARS AND FISHING TECHNOLOGY Credits 06

C11T: FISHING CRAFTS, GEARS AND FISHING TECHNOLOGY

(Theory) **Credits: 04**

1. **Fishing Craft:**History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance oif fishing vessels. fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.
2. **Fishing gears:**Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization ofFishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears.Classification of fishing gears.Gear building materials, Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears.
3. **Fishing Technology:** Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid water trawling. Constructional details of single boat purse seine; two boat purse seine and method of operation. Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom , mid water and pelagic gillnetting. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

C11P: FISHING CRAFTS, GEARS AND FISHING TECHNOLOGY (Practical)

Credits: 02

1. Studies on traditional fishing crafts operated in inland and marine fishing.
2. Identification of wooden boat; General view of boat; Drawing of sheer plan, body plan and half breadth plan; Typesof marine engines and their installation of engines. Visit to boat building yard and dry dock.
3. Study of net making tools; Knots and hitches used in net making. Methods of netmaking: Hand braiding- Chain mesh method and loop methods of net making.
4. Shaping of webbing:baiting, creasing and reducing mesh size step by step.

5. Methods of net mounting:receiving, stapling and norselling. Mending and net shooter techniques.
6. Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Riggingof trawl, purse seine, gillnet and hook & line.
7. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Castnet fishing and trap fishing.

CC-12: POST HARVEST TECHNOLOGY, FISH AND AQUACULTURE PRODUCTS AND BI-PRODUCTS Credits 06

C12T: POST HARVEST TECHNOLOGY, FISH AND AQUACULTURE PRODUCTS AND BI-PRODUCTS (Theory) Credits: 04

1. **Post harvest technology:** 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 preservation. Methods and equipment for chilling; icing – quality of ice, ice-making; refrigerated of chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Objectives of packaging requirements. Characteristics of various packaging materials – metals, paper and paperboard, corrugated fibre board, plastics, multiplayer and – testing of packaging materials and containers. Sun drying, Curing, Wet curing and Smoking. Colombo curing, Artificial drying, Solar drier, Tunnel dryer, Freeze dryer, Water activity and its relation to fish preservation. Fish byproducts and value added products.
2. **Fish and Aquaculture Products**: Marinaded and fermented fish products–role of acids in marinades, Fish and prawn pickles, fishsauce and Fish paste, traditional Indian fermented products. Fermented fish products of SoutheastAsia.Principles and methods of preparation of various fish paste products like fish sausage, fishham, surimi, fish cake, kamaboko etc. Extruded products – theory of extrusion, equipments used, advantages ofextruded products, methods of preparation of extruded products.Value addition. Diversified fishproducts: battered and braided products fish finger, fish cutlet, fish wafer, and fish soup powderetc.and imitation products. HACCPin safe products production.
3. **Fish By-Products**: Fish meal. Dry reduction and wet reduction methods – specification – packaging and storage. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application. Shrimp wastes – chitin – chitosan - production – uses. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and the irincorporation to various products. Fish silage – acid silage – fermented silage – application. Fishmaws, shark leather, fishglue, fish gelatin, isinglass, pearlessence, shark finrays, beach - de - mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

C12P: POST HARVEST TECHNOLOGYFISH AND AQUACULTURE PRODUCTS AND BI-PRODUCTS (Practical) Credits: 02

1. Sanitation and plant housekeeping; chilling and freezing equipment, instruments;packages and product styles; methods of icing fish.

2. Preparation of salted fish, dried fish and smoked fish by different methods. Qualityassessment of salted, dried and smoked fish.
3. Preparation of prawn & fishpickles. Preparation offermented fish sauce and marinaded products. Preparation of surimi and surimi based products.
4. Preparation of diversified and valueadded fishproducts.
5. Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage,ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure
6. Preparation of fish protein concentrate and fish hydrolysate.

CC-13: (FISH DISEASE, IMMUNITY AND HEALTH MANAGEMENT Credits 06

C13T: (FISH DISEASE, IMMUNITY AND HEALTH MANAGEMENT)

(Theory) Credits 04

1. **Fish Disease:** General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. Significance of finFish and Shellfish diseases in aquaculture. Host, Pathogen and Environment Interaction. Disease development process. Stress in aquaculture and its role in disease development. Pathological processes: Cellular response to injury, Inflammatory response to diseases, Pathogencity mechanism of parasite, bacteria, virus and fungus.Important disease problems of cultured shellfish and their control.
2. **Immunity:** Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types. epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions.Antigen and antibody. Classification of immunity. Humoral and cell mediated immunity.Antigen-antibody reaction,Macrophages. Specific and nonspecificdefence system in fish. Introduction to fish immunization andvaccine production. Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action.
3. **Health Management**: Disease surveillance and reporting.Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Bio-security principles, Sanitary and phytosanitary Agreement, Disease control through environmental management. Importance of Biofilm, Biofloc, Periphyton in aquatic Health Management.

C13P: FISH DISEASE, IMMUNITY AND HEALTH MANAGEMENT

(Practical) Credits 02

1. Live and post mortem examination of fish and shellfish. Pathology of organ systems.Histopathology of normal and diseases fish and shellfish, Diagnosis of abiotic fish diseases.
2. General procedure for disease diagnosis. Methods of sampling fish and shellfish fordisease diagnosis.
3. Taxonomy, lifecycle and identification of fish and shellfish parasites.

4. Sampling,preparation of media and culture of pathogenic bacteria: Techniques for bacterial classification.
5. Techniques in disease diagnosis: Microbiological, haematological, Histopathological,immunological, molecular techniques and Biochemical tests.
6. Collection, separation and identification of fish leucocytes. Separation of blood plasmaand serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types ofleukocytes and isolation of macrophages.

CC-14: POPULATION DYNAMICS AND STOCK ASSESSMENT AND THERAPEUTICS IN AQUACULTURE Credits 06

C14T: Population Dynamics and Stock Assessment and Therapeutics in aquaculture (Theory) Credits 04

1. **Population dynamics and Stock Assessment:**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. 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 overfishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

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

C14P: POPULATION DYNAMICS AND STOCK ASSESSMENT AND THERAPEUTICS IN AQUACULTURE (Practical) Credits 02

1. Study of length – weight relationship, segregation of stock using direct methods.

2. Studyof analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models.
3. Estimation of net selectivity coefficient. Fitting of surplusproduction model: Schaeffer
4. Regulations of drug use. Introduction to antimicrobials, preparation of potassium permanganatesolution, preparation of weak Tincture Iodine.
5. Five-platescreening test for the detection of antibiotic residue.
6. Calculation of different disinfectants dosage intreating fish ponds.
7. Generic name, patent name, dosage and indications of various aquaculture drugsused in fish health.

Discipline Specific Elective (DSE)

DSE-1: FISHERIES BIOTECHNOLOGY, BIOINFORMATICS AND STATISTICS **Credits 06**

DSE-1T: FISHERIES BIOTECHNOLOGY, BIOINFORMATICS AND STATISTICS

(Theory) **Credits 04**

1. **Fisheries Biotechnology:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors.

2. **Bioinformatics**: Introduction to Bioinformatics; Biological Databases and tools : Introduction;Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents;Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS,Molecular visualization Sequence analysis.

3. **Fisheries Statistics**: Definition of sample, population in biometry: Frequency distribution, histogram, bar diagram, pie diagram. Measures of central tendencies (Mean, Median and Mode), Dispersion (SD, SE and Variance). Chi squire (X2) test and Student's t-test. Regression analysis and ANOVA test.

DSE-1P: FISHERIES BIOTECHNOLOGY, BIOINFORMATICS AND STATISTICS

(Practical) **Credits 02**

1. Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform.
2. Study of structure of prokaryot and Eukaoryt Cells. Study on Model of protein Synthesis, Study of models rDNATechnology, Cell Culture
3. Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNAsequence analysis and comparison.
4. Draw a histogram, bar diagram, pie diagram, chart etc
5. Collection of data and presentation of data. Testing of Goodness of fit; Chi squire (X^2)test and Student's t-test.

DSE-2:POST-HARVEST TECHNOLOGY AND QUALITY ASSURANCE OF FISHERY PRODUCTS **Credits 06**

DSE-2T:POST-HARVEST TECHNOLOGY AND QUALITY ASSURANCE OF FISHERY PRODUCTS (Theory) **Credits 04**

1. **Post harvest technology:**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 preservation. Methods and equipment for chilling; icing – quality of ice, ice-making; refrigerated of chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Objectives of packaging requirements. Characteristics of various packaging materials – metals, paper and paperboard, corrugated fibre board, plastics, multiplayer and – testing of packaging materials and containers. Sun drying, Curing, Wet curing and Smoking. Colombo curing, Artificial drying, Solar drier, Tunnel dryer, Freeze dryer, Water activity and its relation to fish preservation. Fish byproducts and value added products.

2. **Quality assurance of fishery products**: Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Preharvestand post harvest factors affecting quality. Assessment of quality changes in fresh and icedfish. Quality changes during processing. Importance of quality, definitions and terminologies.Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen,canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnelhygiene, planning and layout, equipment construction and design. Food laws and standards,national and international legislation, mandatory and non mandatory standards. Role of exportinspection council & export inspection agency and MPEDAin fish and fishery products. Certification system for fish & fishery products. The HACCPfor seafood industries and protection of food from adulterants. Standardsfor sea foods.FSSA, FDA, ISO.Use of additives in seafood processing as quality enhancers.Seafood safety, authenticity, traceability. Waste management in seafood processing.

DSE-2P:POST-HARVEST TECHNOLOGY AND QUALITY ASSURANCE OF FISHERY PRODUCTS (Practical) **Credits 02**

1. Sanitation and plant housekeeping; chilling and freezing equipment, instruments;packages and product styles; methods of icing fish.
2. Preparation of salted fish, dried fish and smoked fish by different methods.
3. Preparation of prawn & fishpickles. Preparation offermented fish sauce and marinaded products. Preparation of surimi and surimi based products.
4. Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods.Chlorination and Hardness estimations.
5. Quality analysis of canned, frozen, cured and pickled fishproducts. Quality tests for tin and corrugated containers. Qualityassessment of salted, dried and smoked fish
6. Assessment of plant, equipment sanitationand personnel hygiene. Detection of filth and extraneous matter in traditional processed products

DSE-3: FISHERIES ECONOMICS , FISHERIES POLICY AND LAWS AND ENTREPRENEURSHIP DEVELOPMENT **Credits 06**

DSE-3T: FISHERIES ECONOMICS , FISHERIES POLICY AND LAWS AND ENTREPRENEURSHIP DEVELOPMENT(Theory) **Credits: 04**

1. **Fisheries Economics:**Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics,positive and normative economics, environmental economics, resource, scarcity, farm-firmrelationships, production Contribution of fisheries sector to the economic development of thecountry. Micro-economics: theories of demand, supply; market – equilibrium price, consumption,utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheriesmanagerial decision. Farm productioneconomics – production functions in capture and culturefisheries; 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 toscale, economies of scale and scope, revenue, profit maximization, measurementoftechnological change, farm planning and budgeting. Significance or importance of marginal cost.

2. **Fisheries policy and laws:**Introduction to public administration, principles of organization and management ofpublicenterprise. Central and State responsibilities for fisheries development, organizational set upof fisheries administration at the Centre and state levels. Present relevance of past fisheries policiesand recent policies in fisheries sector. Functions and powers of functionaries of department offisheries, corporations and cooperatives. Different central and state level fisheries institutions. Roleof Central and State Government in the regulatory activities of Aquaculture and fisheries.Fisheries

legislation: Overview of fisheries and aquaculturelegislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act andEnvironmental (Protection) Act. International environmental legislation and its impact on fisheries. Brackish wateraquaculture act, Marine fisheries policy, Laws relating to fish products and marketing.

3. **Entrepreneurship Development**: Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing anenterprise; motivation and entrepreneurship development; importance of planning, monitoring,evaluation and follow up; managing competition; entrepreneurship development programs;Generation, incubation and commercialization of ideas and innovations. Government schemes andincentives for promotion of entrepreneurship. Preparation of enterprise budget for integrated fishfarming. Fiscal and monitory policies and its impact on entrepreneurship. Infrastructural and otherfinancial requirement for fishery entrepreneurship Government policy on Small and Medium. Enterprises (SMEs) / SSIs. Venture capital. Contract farming and joint ventures, public-privatepartnerships. Overview of fisheries inputs industry. Characteristics of Indian fisheries processingand export industry.

DSE-3P: FISHERIES ECONOMICS, FISHERIES POLICY AND LAWS AND ENTREPRENEURSHIP DEVELOPMENT

(Practical) **Credits 02**

1. 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
2. Demand and supply functions of fish market – determination of equilibrium price forfish and fisheries products, calculation of price, income and cross elasticity.
3. Production function – production with one or two variable inputs. Shifting demand and surplus curve and its importance in fish price.
4. Economic analysis on cost, return and breakeven of any two production units like fish farm / shrimp farm / seed production unit /fish processing plant / export unit.
5. International Law of the Seas and international commissions on fisheries and their impact.

DSE-4: TRAINING / PROJECT WORK **Credits 06(0+6)**

Skill Enhancement Course (SEC)

SEC-1: ORNAMENTAL FISH PRODUCTION AND AQUARIUM MANAGEMENT

(Practical) **Credits: 02**

1. Identification of freshwater and marine water ornamental fishes and plants.
2. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment.
3. Conditioning and packing of ornamental fishes.
4. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes.
5. Identification of ornamental fish diseases and prophylactic measures.
6. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.

SEC-2:FISH BREEDING AND HATCHERY MANAGEMENT OF CARP/CATFISH/ PRAWN

(Practical) **Credits: 02**

1. Study of maturity stages in fishes. Estimation of rate of inbreeding and heterosis. Mitotic and meiotic chromosome preparation.
2. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene andgenotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt.
3. Collection and preservation of fish pituitary gland,preparation of PG extract, Hypophysation. Calculation of fecundity.
4. Brood-stock maintenance andselection of breeders for injection. Histological studies of ovary and testes. Different fish hatcherysystems, study of fish eggs and embryonic developmental stages. Identification of eggs,spawn, fry and fingerlings of different species.
5. Preparation and management of fish nursery.Fish seed and brood-stock transportation, use of anesthetics, disinfectants and antibiotics in fishbreeding.
6. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing ofcommon finfishes/shellfishes.

GENERIC ELECTIVE (GE)

[Interdisciplinary for other department]

GE-1 : Fundamentals of Fisheries & Aquaculture Credits 06

GE-1 T: Fundamentals of Fisheries & Aquaculture

(Theory) **(Credits: 4)**

1. General knowledge about fish.
2. Commercially important freshwater and marine water Fin fishes& Shellfishes, their economic value.
3. Different system of Aquaculture: Extensive, semi-intensive, intensive culture of fish.
4. Non-conventional Aquaculture: Pen-culture, cage-culture, race-way culture, Jhora fisheries.
5. Role of Aquaculture for development.
6. Fisheries co-operatives: Principle of fishermen co-operatives, formation of co-operatives, bylaws, advantage of co-operatives.

GE-1 P: Fundamentals of Fisheries & Aquaculture

(Practical) **(Credits: 2)**

1. Identification of commercially important freshwater and marine water Finfish & Shellfishes.
2. Study of cultivable species of shellfishes.
3. Collection of predatory and weed fishes.
4. Identification of aquatic weeds.
5. Study of catfishes.

GE-2 : Inland fisheries resources, fish breeding and seed production Credits 06

GE-2 T: Inland fisheries resources, fish breeding and seed production Credits 04

(Theory)

1. Present prospect and problems of Inland fisheries in India.
2. Inland fisheries resources.
3. Freshwater fishery resources of the world and their major fisheries.
4. Different types of fish ponds, criteria for ideal fish culture pond, pre-stocking management of nursery, rearing and stocking ponds.
5. Culture practice of spawn, fry and fingerling in different rearing ponds.
6. Induced breeding of fishes: History of Induced breeding in fish, Bundh breeding, Environmental and hormonal control of fish reproduction, Structure of pituitary gland and its secretion, Use of synthetic hormones, brood fish management, different types of hatchery for IMC breeding.

GE-2 P: Inland fisheries resources, fish breeding and seed production (Practical) Credits 02

1. Pituitary gland collection, preservation, preparation of pituitary gland extract for injection.
2. Identification of different life stages of cultivable fish species: spawn, fry, and fingerling.
3. Study of model hatchery.
4. Study of external morphology, collection, preservation and identifications of prawn, crabs, lobsters, bivalves from natural habitats.
5. Study of care of eggs, spawn and fry.

GE-3 : Marine fisheries and oceanography Credits 06

GE-3 T: Marine fisheries and oceanography (Theory) Credits: 04

1. **Marine Fisheries:**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.

2. **Oceanography:** Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction.Physical properties of sea water: Salinity and chlorinity; temperature; thermal 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.

GE-3 P: Marine fisheries and oceanography (Practical) Credits: 02

1. Observation and analysis of catches by major crafts andgears operated in marine fishing.

2. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevantdata.
3. GIS and remote sensing in marine capture fishery.

4. Field visits and operation of oceanographic instruments- Nansen reversing watersampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder.

5. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate,Nitrite, Phosphate and Silicate in sea water
.

GE-4 : FISH AND AQUACULTURE PRODUCTS AND BY-PRODUCTS FOR HEALTH AND NUTRITION Credits 06

GE-4 T: (FISH AND AQUACULTURE PRODUCTS AND BY-PRODUCTS FOR HEALTH AND NUTRITION) (Theory) Credits: 4

1. **Fish and Aquaculture Products**: Marinaded and fermented fish products–role of acids in marinades, Fish and prawn pickles, fishsauce and Fish paste, traditional Indian fermented products. Fermented fish products of SoutheastAsia.Principles and methods of preparation of various fish paste products like fish sausage, fishham, surimi, fish cake, kamaboko etc. Extruded products – theory of extrusion, equipments used, advantages ofextruded products, methods of preparation of extruded products.Value addition. Diversified fishproducts: battered and braided products fish finger, fish cutlet, fish wafer, and fish soup powderetc.and imitation products. HACCPin safe products production.

2. **Fish By-Products**: Fish meal. Dry reduction and wet reduction methods – specification – packaging and storage. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application. Shrimp wastes – chitin – chitosan - production – uses. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and the irincorporation to various products. Fish silage – acid silage – fermented silage – application. Fishmaws, shark leather, fishglue, fish gelatin, isinglass, pearlessence, shark finrays, beach - de - mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

GE-4 P: (FISH AND AQUACULTURE PRODUCTS AND BY-PRODUCTS FOR HEALTH AND NUTRITION)(Practical) Credits: 02

1. Preparation of salted fish, dried fish and smoked fish by different methods. Qualityassessment of salted, dried and smoked fish.
2. Preparation of prawn & fishpickles. Preparation offermented fish sauce and marinaded products. Preparation of surimi and surimi based products.
3. Preparation of diversified and valueadded fishproducts.
4. Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage,ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure
5. . Preparation of fish protein concentrate and fish hydrolysate.