I. DEPARTMENT OF INLAND AQUACULTURE

Ph.D. (Aquaculture)

Major courses

1. AQC 601. Advances In Aquaculture Production Systems 3(2+1)

Theory

UNIT I

An overview of aquaculture production systems: Present status, constraints and future perspectives of aquaculture production systems in India and the world.

UNIT II

Advances in design and construction: Hatcheries; Earthen ponds; Concrete tanks; Pens and cages; Rafts; Racks.

UNIT III

Aquatic plant production systems: Ornamental aquatic plants; microalgae and seaweeds; Long line production system.

UNIT IV

Aquaculture production management: Monitoring of water quality; feeding and monitoring, sampling and harvesting of finfishes and shellfishes.

UNIT V

Advances in farming systems: Enhancing carrying capacity; integrated farming systems; semi-intensive and intensive culture systems; Recirculatory system; Flow-through system.

UNIT VI

Code of conduct for responsible and sustainable aquaculture. Cluster farming, Organic Farming, Satellite Farming and Co-operative farming.

Practical

Soil and water quality monitoring; Basic software packages for designing aquaculture systems; Preparing a model layout for advanced production system; Working out the economic feasibility of construction and maintenance of different fish production systems ; Preparation of project proposal for fish production systems.

2. AQC 602. Advances in Seed Production and Hatchery Management 3(2+1)

Theory

UNIT I
Reproductive biology of important fishers, crustaceans and molluscs. Anatomy and morphology of reproductive organs. Reproductive behavior of fishes. Sex determination in fishes.

UNIT II
Reproductive endocrinology: Anatomy and physiology of endocrine glands. Biochemical characteristics of endocrine hormones. Role of endocrine hormone in reproduction.

UNIT III
Broodstock management: Factors affecting the maturation and spawning of fin fishes and shell fishes. Nutritional and environmental requirement for broodstock. Nutritional and environmental manipulation for early maturation. Criteria for the selection of brood stock. Selective breeding strategies; Tagging; Transportation of brood stock. Natural and synthetic anesthetics for transport. Vaccines and therapeutics for health management of broodstock.

UNIT IV
Induced Spawning: Biochemical characteristics of synthetic hormone analogues and their applications. Comparative evaluation of commercially available inducing agents. Artificial insemination in crustaceans and molluscs. Cryopreservation of gametes and embryos.

UNIT V
Seed production and hatchery technology: Advances in seed production of commercially important finfishes and shellfishes. Seed production of ornamental fishes. Artificial propagation of seaweeds.

UNIT VI
Hatchery management: Water quality management in hatcheries - Chemical, Physical and Biological approaches. Nutritional requirement of larvae and post larvae. Live feed culture. Nutritional enrichment of live feed. Formulation of artificial diets. Strategies to control diseases in hatcheries. Diagnosis, quarantine and seed certification. Use of Probiotics and Immunostimulants in hatcheries, SPF and SPR. Effluent treatment in Hatcheries. Seed transportation methods.

Practical
Insemination; Cryopreservation of fish and shellfish gametes; Project preparation for constructing hatchery; Quantitative and qualitative determination of fish gametes like sperm motility, viability, counts; Digital equipments in broodstock management; Methods to identify quality seeds - stress test, microscopic examination.

3. AQC 603. Aquaculture and Ecosystem Management 3(2+1)

Theory

UNIT I
Aquaculture and ecosystem relationship: Ecosystems and productivity, biotic interaction within ecosystems and ecological homeostasis.

UNIT II
Climate: Weather elements of concern in aquaculture, Green house gases, global warming and their impact.

UNIT III
Impact of environment on aquaculture: Raw water source, physical and chemical characteristics, contaminants and pollutants (algae, pathogens, heavy metals, pesticides) and their effect on productivity.

UNIT IV
Impact of aquaculture on environment: Waste water discharge, its quality and quantity; impacts of effluents on ecosystems, chemical degradation of soil and water.

UNIT V
Environment monitoring: Problems and preventive measures of antibiotic and drug residues, salination of soil and water, Eutrophication, Environment impact assessment and environmental audit, Biosensors in aquatic environment, toxicity assessment, Ecolabelling and traceability.

UNIT VI
Environment management: Introduction of exotics and escape of farmed fish, Pathogens in aquatic environment, Safety of aquaculture products, Role of microbes in aquatic environment; assessment of probiotic impact in aquaculture.

Practical
Waste water analysis; Environment impact assessment; Environmental audit; Toxicity assessment studies; Ecolabelling and traceability; Isolation, enumeration and Identification of bacterial population; Physical and chemical characteristics of soil; Design and construction of effluent treatment plant.

4. AQC 604. Aquatic Animal Health Management and Quarantine 2(1+1)

Theory

UNIT I

Defence mechanism in fish and shellfish: Specific and non-specific defence mechanism, immunogenicity, immune cells, immune suppressant, ontogeny of immune system; cellular adaptation, pathogen specificity.

UNIT II

Disease diagnostics tools: Histopathological methods, tools used in different types of PCR, Immunoassay, Biochemical assay, Monoclonal and polyclonal based antibody assay, Electron microscopy, Serological techniques.

UNIT III

Disease prevention and therapeutics: Vaccines and bactericins, development of vaccines like DNA vaccine, adjuvants, etc; administration and mode of action of pathogen specific drugs, drug resistance, antiviral drugs, drug regulation in India, pharmacokinetics and pharmacodynamics, immunostimulants.

UNIT IV

Quarantine: Biosecurity principles, SPF and SPR, quarantine protocols, and facilities, broodstock and seed quarantine measures, Quarantine of Aquatic Animals and Premises.

Practical

Analysing and reporting legal problems relating to quarantine; Microscopic techniques; Immunisation techniques; Necropsy examination to study internal organs of fish; PCR; ELISA; Agglutination test; Gel electrophoresis; Histopathology; Determination of dosages of chemicals and drugs for treating common diseases.

5. AQC 605. Fish and Shellfish Physiology and Endocrinology 2(1+1)

Theory

UNIT I
General physiology and endocrinology: Physiology of migration and behaviour, chemical nature of hormones, storage, release and control of hormones, serochemistry, structure and function of neuro-endocrine system, biotic and abiotic factors influencing homeostasis, ecophysiology, endocrine control of growth.

UNIT II
Nutritional and digestive physiology: Mechanism of chemo, electro and mechanorecption, gustation, digestive enzymes and isozymes, nutrient tansporters, gut microbial digestion, excretion.

UNIT III
Neurophysiology: Neurosecretory system in fishes, crustaceans and molluscs, neurotransmitters, ecdysis.

UNIT IV
Reproductive physiology: Maturation and spawning, spermatogenesis, oogenesis, yolk formation, mechanism of sex reversal.

UNIT V
Respiratory physiology: Structure and chemical composition of respiratory pigments, gas exchange concept, osmoregulation.

UNIT VI
Stress physiology: stress response, stress hormones, stress adaptation.

Practical
Hormone assay –RIA (Radio Immuno Assay); Dissection of fin and shellfish to study endocrine glands; Histological techniques to study endocrine cells; Identification of moult stages; Serological analysis; Application of Electrocardiogram and respirometer.

6. AQC 609. Applied Biotechnology 2(1+1)

Theory

UNIT I
Introduction: Scope of biotechnology in fisheries and aquaculture research.

UNIT II
Transgenics: Principles of transgenic technology and its application in fisheries.

UNIT III
Feed biotechnology: Probiotics, single cell proteins, Nutraceuticals.

UNIT IV
Recombinant proteins of commercial importance: enzymes, hormones, bioactive compounds, therapeutic proteins.

UNIT V
Biotechnological approaches in environmental management: Bioremediation, biosensors, biofouling, treatment of waste water.

UNIT VI
Anti microbial Peptides and their applications.

UNIT VII
Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines.

UNIT VIII
Applications of biotechnological tools: Recombinant DNA, Monoclonal antibodies, Cell lines and stem cell culture, DNA markers and MAS.

UNIT IX
Biotechnological instrumentation in Aquaculture.

Practical
Cell culture and cell lines; Development of hybridoma and production of monoclonal antibodies; Collection, handling and observation of gametes of finfish and shellfish; Preparation of chromosomes from embryos and young fish; Ploidy determination by RBC measurement and chromosome numbers; Gene transfer experiments: northern blotting and southern blotting for integration and expression of transgenes.

Minor courses

1. AQC 606. Advances in Fish Genetics 3(2+1)

Theory

UNIT I
Scope of applied fish genetics: Inheritance of qualitative and quantitative traits in fish; chromosomal polymorphism.

UNIT II
Non chromosomal inheritance: Mitochondrial inheritance.

UNIT III
Chromosome manipulation: Gynogenesis and androgenesis; production of super-males and transgenic fish.

UNIT IV
Inbreeding and genetic drift: Estimation of genetic parameters.

UNIT V
Selective breeding: Qualitative and quantitative traits for selection, methods of selection-individual selection, mass selection, family selection and combined selection; Designing of breeding programmes.

UNIT VI
Genetic markers: Use of biochemical and molecular genetic markers in hybridization, selective breeding.

UNIT VII
Diallele crossing: Genetic improvement of particular trait (disease resistance) in fish.

UNIT VIII
Chromosome banding techniques: C-banding, G-banding, NOR-banding, FISH.

UNIT IX
Genotoxicity assay: Comet assay, sister chromatid exchange, MNT, etc.

Practical
Chi-square test; Estimation of heritability and repeatability; Assessment of genetic gain through selection; Calculation of selection differential; Calculation of selection response; Estimation of inbreeding coefficient and path coefficient; Karyotypic studies; C-banding (hetero chromatin banding); NOR- banding (nucleolar organizer region banding); G-banding (Giemsa banding); Ploidy determination methods.

2. AQC 607. Intensive Farming Systems for Tilapia and Catfishes 3(2+1)

Theory

UNIT I

Intensive Farming Systems: Status and future prospectus of catfishes and tilapia in India, Need for intensification, Development of intensive farming. Disease and its control, constraints in intensive farming.

UNIT II

Catfish: Commercially important catfishes, Different culture systems, Means of intensifying catfish culture, polyculture of catfish with other species, Water quality management in catfish culture, feeds and feeding, Economics of culture.

UNIT III

Tilapia: Commercially important tilapia, Different culture systems, Means of intensifying tilapia culture, polyculture of tilapia, Water quality management in tilapia culture, feeds and feeding, Techniques of sex reversal in tilapia, mass production of monosex seed and hybrids, Production of red tilapia, Economics of culture.

Practical

Study of aerators and blowers; Experience in breeding and culture of catfish; Experience in breeding and culture of tilapia; Seed production of catfish and tilapia; Formulation of feeds for catfish and tilapia; Stocking density manipulation and fish production; Economics of intensive farming of catfish and tilapia.

3. AQC 608. Aquaculture Development Planning and Management 2(1+1)

Theory

UNIT I

Importance, principles and processes in developing aquaculture programmes; Planning for sustainable development; Types of planning; Planning strategies at various levels - Top down and bottom up approaches. Role and relevance of Panchayati Raj institutions in aquaculture development; Plan allocation and performance of FFDA, BFDA and other aquaculture related programmes over the different plan-periods in India.

UNIT II

Project preparation and project appraisal in terms of social benefit analysis, shadow prices; Project management techniques - PERT and CPM; Logical framework approach (LFA), Stakeholder analysis; Participatory Monitoring and evaluation (PROME); People's participation in aquaculture programmes, significance, importance and approaches .

UNIT III

Critical analysis of aquaculture and rural development programmes; design, operation, institutional mechanism and socio-cultural and economic impact of programmes such as NREGA; labour market relations; Fisheries development *vis-à-vis* fisheries for development; Livelihood Frameworks.

Practical

Need assessment, setting objectives, developing plan of work, Success indicators, Impact assessment of aquaculture development programmes, SWOT analysis; Exercises on PERT and CPM. Fisheries and Aquaculture policies of select countries; Study visits to selected aquaculture project areas – FFDA/ BFDA/ SAUs/ICAR institutes.

II. DEPARTMENT OF FISHERIES BIOLOGY AND RESOURCE MANAGEMENT

Ph.D. (Fisheries Resource Management)

Major courses

1. FRM 601. Assessment of Aquatic Biodiversity 3(2+1)

Theory

UNIT I
Definitions and measurement: Methods, scales and indices of biodiversity assessment.

UNIT II
Biodiversity (microalgae to aquatic vertebrates) of any three of the following or similar ecosystem: Chilka Lake, Narmada river system, Gangetic system, Jaykwadi reservoir, Himalayan lake, Himalayan river, Hooghly Maltah estuarine system, Coramandondal coast, Gulf of Mannar, Gulf of Kutch, Malabar upwelling, Bhitarkanika.

UNIT III
Threats to biodiversity: Overexploitation, land reclamation, pollution, habitation, conversion of agricultural land and aquacultural farms (case studies pertaining to any sensitive marine/estuarine/freshwater hot spots).

UNIT IV
Conservation and Restoration: Declaration of mangrove sanctuaries and mangrove afforestation, marine protected areas, Ganga Action Plan, introduction of exotic species and their implications; potential consequences and conflicts of linking rivers.

UNIT V
Impacts of anthropogenic intervention on aquatic biodiversity: Damming of rivers, construction of sea walls, micro hydel power stations, oil rigs.

UNIT VI
Legal regimes of biodiversity: International and national conventions and Acts for biodiversity.

UNIT VII
Institutionalization of biodiversity conservation (Such as creation of Biodiversity Boards/Authority.

Practical
Preparation of records and inventories of biodiversity of any three critically important ecosystem based on secondary data and field visits- Compilation of all important International and National laws and conventions related to biodiversity

2. FRM 602. Applications of Fisheries Models in Stock Assessment 3(2+1)

Theory

UNIT I
History and development of analytical models; Analytical models; its history and development.

UNIT II
Application of Beverton and Holt's, Thompson and Bell models in trophics.

UNIT III
Logistic models of Schaefer and Fox.

UNIT IV
Prey predator models. 4. Stock recruitment models of Ricker, Beverton and Holt.

UNIT V
Bioeconomic modeling.

UNIT VI
Ecopath and ecosim models.

Practical
Application of logistic and analytical models in marine, riverine and estuarine systems. Ecopath modeling based on secondary data.

3. FRM 603. Conservation and Management of Exploited Fisheries Resources 3(2+1)

Theory

UNIT I
Marine parks, marine protected areas, biosphere reserves, closed seasons.

UNIT II
Cryopreservation of exploited and endangered species.

UNIT III
Fishing regulation policies - A critique on the draft Indian Fisheries policy. A critical appraisal of Inland Fisheries Legislation of any two states of India.

UNIT IV
Protection of habitat of corals, mangrove, seaweeds, sea grass beds. Implementation of square cod end mesh – to reduce by-catch.

UNIT V
Legal proceedings / implementation for protection of exploited and endangered fishery resources.

UNIT VI
Total allowable catch, regulation of mesh size for conservation of exploited fishery resources.

UNIT VII
Management of major reservoirs of India; optimal stocking and production of cultivable resources.

UNIT VIII
A comparative study of the marine regulation acts of any two neighboring countries with reference to Environmental Protection Act (EPA).

UNIT IX
Compile the rules relating to marine fisheries exploitation included in the final UNCLOS III treaty.

Practical
Based on the existing policy, suggest and draft ideal inland and marine fishery legislation for any one Indian State. With reference to the laws of the sea (UNCLOS III) treaty, recommend ways and means to solve dispute of shared stocks. Develop a framework for conflict resolution of traditional and mechanized fisheries.

4. FRM 604. Coral Reef Management 3(2+1)

Theory

UNIT I
Type of coral reefs and their distribution.

UNIT II
Origin of coral reefs – coral reefs of the world.

UNIT III
Ecology of coral reefs; factors influencing growth; productivity of coral reefs; plants and animals associates of living reef corals and fringing reefs.

UNIT IV
Nutrition, production, larval dispersal and settlement of corals.

UNIT V
Soft coral type and their ecology.

UNIT VI
Bioactive substances of soft and hard corals, sedimentation in coral reef environment.

UNIT VII
Economic importance of coral reefs.

UNIT VIII
Management and conservation of coral reefs and soft corals.

Practical
Collection and identification of soft and hard corals; Survey of corals and mapping; identification of associated organisms; preparation of checklist and associated organisms of Indian coast. Predatory animals of corals, Extraction of bioactive substances from soft and hard corals. Observations of destructive methods of corals and coral reef fishes.

5. FRM 606. Fisheries Environmental Assessment 3(2+1)

Theory

UNIT I
Critically important climatic factors (temperature, rainfall and wind pattern / monsoon influencing aquatic (inland and marine) productivity and production.

UNIT II
Remotely sensed SST, Chlorophyll and Wind pattern features of Indian seas used in locating Potential Fish Zones (PFZ).

UNIT III
Influence of rainfall intensity, its seasonal and annual variations on fish migration, breeding, recruitment and production. (Correlation of rainfall data from IMD and catch data on fishes from same region for bringing out the impact of rain on production).

UNIT IV
Optimum water quality parameters prescribed for various water bodies (marine and inland) for different user groups including fisheries.

UNIT V
Environmental Impact Assessment of various anthropogenic causes; domestic and industrial water discharge into waters and their impact on fisheries. Tannery discharge and its impact on fisheries.

UNIT VI
Status, structure and trophic profile (at primary, secondary and tertiary levels) of four typical water bodies: i) Marine, ii) Estuarine iii) Reservoir iv) River in relation to nutrient profile, plankton profile and oxygen profile in spatial and temporal terms.

Practical
Preparation of isoclines of temperature, rainfall and chlorophyll pattern of data gathered from satellites and demarcation of the PFZ's. Development of a graphic picture of the vertical and horizontal profiles of various nutrients, temperature, oxygen, plankton and fish density of any well defined aquatic system.

Minor Courses

1. FRM 605. Data Collection and Estimation of Exploited Fisheries Resources 2(0+2)

Practical

Collection of fishery data at landing centres from different gears separately. Details of craft and gear of landing centres. Recording of data in the entry forms. Definition of length for various groups of fish/crustaceans/molluscs. Collection of length frequency data of fishes at landing centres. Estimation of age and growth based frequency data. Growth, mortality, population and stock parameters employing FiSAT, Length structured VPA, Thompson and Bell yield stock prediction for single and multifleet version. Beverton and Holt yield-per-recruit model; biomass-per-recruit. Relative yield-per-recruit model and yield isopleth diagram.

2. FRM 607. Issues in Capture Fisheries 2(1+1)

Theory

UNIT I

Over- capacity (excessive fishing efforts); Over exploitation. By-catch and Discards.

UNIT II

IUU (Illegal, Unregulated and Unreported) Fishing. Problems encountered in Monitoring, Control and Surveillance (MCS).

UNIT III

Ghost fishing, destructive fishing practices.

Practical

Assessment of fishing capacity; stages of overexploitation, case studies and field visits.

III. DEPARTMENT OF FISH PROCESSING TECHNOLOGY

Ph. D (Fish Processing Technology)

Major courses

1. FPT 601. Biochemical Techniques in Fish Analysis 3(2+1)

Theory

UNIT I
General principles of separation of micro and macro molecules, selection of appropriate tools for analysis of fish samples. Outlines of common techniques involved in biochemical analysis.

UNIT II
Centrifugation techniques: types of centrifugation, concept of Svedberg unit, analytical ultracentrifuge.

UNIT III
Filtration technique: different types of filtration, types of filters and means of using them.

UNIT IV
Spectroscopic techniques: Principles, UV, Visible and IR spectroscopy, spectro-fluorimetry, flame photometry, atomic absorption spectrophotometry, ICP- AES, mass spectrometer.

UNIT V
Electrophoretic techniques: General principles, Classification, Paper electrophoresis, Native and reduced PAGE, IEF, capillary electrophoresis, 2D Gel electrophoresis.

UNIT VI
Chromatographic Techniques: General principles, types of chromatography - adsorption, partition, ion-exchange, molecular sieve, affinity, gas chromatography, thin layer chromatography.

UNIT VII
Gas chromatography: Theory and instrumentation.

UNIT VIII
High performance Liquid chromatography, LC MS-MS: Theory and instrumentation.

Practical
Isolation of proteins: sarcoplasmic, myofibrillar, and stromal. Estimation of proteins: Biuret, Lowry and Dye binding technique. Amino acid analysis, non-protein nitrogen. Extraction and estimation of lipids: Measurement of oxidation and hydrolysis of lipids, Fatty acid profile. Minerals and heavy metals: Estimation by Atomic Absorption Spectroscopy and flame photometer. HPLC- determination of histamine Demonstration of GC-MS-MS, Separation of protein by electrophoresis.

2. FPT 602. Functional Properties of Proteins from Fish and Shellfish 3(2+1)

Theory

UNIT I
Definition of functional properties and their importance in proteins from fish. Typical functional properties of proteins in food system.

UNIT II
Protein structure and function: Protein folding and non-covalent forces stabilizing protein structure with special reference to hydrophobic interactions. Free energy and entropy concept in relation to hydrophobic interaction. Surface hydrophobicity and its relation to functional properties. Estimation of surface hydrophobicity and total hydrophobicity.

UNIT III
Solubility and water sorption of proteins: Factors affecting protein hydration. Viscosity in relation to protein hydration: Methods of estimating viscosity.

UNIT IV
Gelation: Definition of gel, mechanism of formation of gel, factors affecting the gel formation. Evaluation of gelling capacity- thermal, rheological and microscopy.

UNIT V
Surfactant properties: emulsifying and foaming. Importance of emulsifying properties of proteins. Theoretical concept of emulsion capacity and stability. Interfacial properties, adsorption from solution. Methods of estimating surface tension.

UNIT VI
Emulsion instability: Creaming, sedimentation, aggregation vs Brownian aggregation. DLVO theory, microemulsions. Methods for estimation of emulsion capacity and stability.

UNIT VII
Macromoleculear absorption and different stages of foaming. Foam stability in relation to proteins structure. Foaming ability of different protein systems with case studies.

UNIT VIII
Denaturation and functionality: Changes in functional properties of proteins as affected by icing, freezing, drying, salting and heating. Modification of proteins for improving functionality- Succinylation and acetylation procedures.

Practical
Evaluation of different functional properties like water absorption, fat absorption,, gelling, emulsification capacity and stability of fish/shell fish proteins. Effect of pH, temperature and ionic strength on various functional properties. Prediction of functional properties using model compounds.

3. FPT 603. Quality Management Systems 3(2+1)

Theory

UNIT I

Quality Management Systems: The concept of total quality management. The principles of TQM. Zero defect planning, Quality circle, Quality link, Quality culture. Statistical Quality Control. Quality as related to preprocess handling, transportation, processing and storage.

UNIT II

Quality evaluation techniques for seafood: Physical, chemical. Bacteriological and Instrumental methods of quality evaluation. Sensory evaluation.

UNIT III

Quality standards: National and International – Codex, USFDA, EU norms, ISO, BIS etc. standards for fish and fishery products.

UNIT IV

Seafood Quality Assurance and Quality Assurance Systems: Good Manufacturing (GMP) and Good Hygiene Practices (GHP) - Codex guidelines. The concept of HACCP in seafood safety. HACCP team Management role and CCPs and implementation procedure for HACCP- ISO 22000 FSMS. ISO 9000 series of standards. Cold schedule and hotschedule for handling perishable commodities.

UNIT V

Validation of methods for quality assurance- Method selection, Quality check, inter-lab comparision, proficiency testing. Primary standards. Reference standards. Reference material (RM), Certified Reference Material (CRM) and Standard Reference Material (SRM), Uncertainty and Calculation of Uncertainty of Measurements.

UNIT VI

Sample Accountability: Sampling plan -probability sampling and non- probability sampling.

Practical

Developing flow charts and exercises in identification of hazards- preparation of hazard analysis worksheet, plan form and corrective action procedures in processing of fish. Analysis of typical hazards, study of correction and corrective action. Detection and estimation of important toxic chemicals in food, quality defects.

4. FPT 605 Microbial Hazards in Fish Processing 3(2+1)

Theory

UNIT I
Public health microbiology- Food borne pathogens: Salmonella, Shigella, Entero-pathogenic E. coli, Clostridium botulinum, Listeria monocytogenes, Staph aureus and Vibrio cholerae, V. parahemolyticus. Emerging food-borne pathogens. Water- borne, Air-borne and food-borne diseases.

UNIT II
Microbial virulence- infectious diseases. Virulence.

UNIT III
Microbial toxin production-opportunists and true pathogens.

UNIT IV
Methods for detection: Rapid detection and indirect detection methods of pathogens and parasites. Method validation.

UNIT V
Antimicrobial systems and food preservation: ecological concepts: Lactoperoxidase. Nisin, Lysozyme, Bacteriocins.

UNIT VI
Norms for using antimicrobial systems in food processing and preservation. Food Safety, Risk analysis. Potential health hazards and risks associated with fish products.

UNIT VII
Packaging and modified atmosphere on the microbiology and shelf life of fishery products.

UNIT VIII
Predictive modeling in quality and safety assurance of fishery products.

Practical
Antibiotic assay, sensitivity tests, evaluation of antibacterial properties. Analysis of fish product constituents. MIC, MCC, Risk analysis of seafood.

5. FPT 610. Fishery by-products, Specialty Products and Value Added Products 3(2+1)

Theory

UNIT I
Nutritional importance of fish meal and quality requirements -Raw material quality and changes during processing and storage.

UNIT II
Nutritional importance of fish oil and methods to impart stability to fish oils on storage, Unsaponifiables in fish liver oils.

UNIT III
Production of fish flour, quality standards and applications.

UNIT IV
Different methods of production of FPC, Different types of FPC, and their specifications.

UNIT V
Enzyme hydrolysis of fish, fish hydrolysates, fish peptones, hydrolysates enriched food beverages.

UNIT VI
Food flavour from tiny prawns and non-penaeid prawns.

UNIT VII
Formulation of pet food.

UNIT VIII
Chitin, Chitosan and protein extract from shrimp and crab shell and squilla, Quality requirements and assessment of chitin and chitosan, Application of chitin and chitosan. Conversion of chitin and chitosan to high value products – glucosamine hydrochloride, glucosamine sulphate and their use.

UNIT IX
Extraction of collagen from fish processing wastes, properties and application. Preparation of biological membranes using collagen and chitosan for biomedical applications.

UNIT X
Value added products: Present market trends, scope of value addition, Types of value addition, Important value added products.

UNIT XI
Coated products – Principles and type of coating, coating functions, in gradients, batter classification, mechanical properties of batter, bread crumbs, flavorings, seasonings and hydrocolloids in coatings, Fat and oils in coated food and their chemistry, Trouble shooting techniques for batter and breading systems, application of batters and breading to seafood.

Practical
Preparation of glucosamine hydrochloride and glucosamine sulphate. Preparation of isinglass, collagen powder and collagen and chitosan. Preparation of fish wafers, fish fingers, cutlets etc.

Minor courses

1. FPT 604. Lipids of Aquatic Origin 3(2+1)

Theory

UNIT I
Lipid classification: Triglycerides, phospholipids, steroids and other lipids. Lipid micelles and bilayer.

UNIT II
Fatty acids: Classification, stereochemistry, nutritional significance of fatty acids.

UNIT III
Source of lipids: Biosynthesis of lipids, lipid metabolism including that of phospholipids, typical properties of marine lipids.

UNIT IV
Lipids in Biological membranes: Membrane proteins, lipoproteins, transport across membranes.

UNIT V
Lipid metabolism: Fatty acid oxidation, ketone bodies, lipid biosynthesis, regulation of cholesterol metabolism. Biological significance of marine lipids. Ether lipids and Eicosanoids-their significance.

UNIT VI
Modern analytical techniques employed in lipid chemistry. Methods of extracting poly-unsaturated fatty acids.

Practical
Extraction and fractionation of lipids. Fatty acid composition of different lipid fractions. Evaluation of oxidation product of fish lipid during processing and storage.

2. FPT 606. Vitamins, Minerals and Flavour Bearing Constituents of Aquatic Organisms 3(2+1)

Theory

UNIT I
Vitamins, minerals, pigments, flavour bearing constituents and other components in aquatic organisms.

UNIT II
Vitamins: Metabolic functions of vitamins, water-soluble and fat-soluble vitamins. Vitamins from sea food.

UNIT III
Minerals: Role of trace elements in metabolism, trace elements of seafood, toxic heavy metals in seafood.

UNIT IV
Pigments and flavour bearing compounds of aquatic origin, chemistry, biochemical role, changes during processing of seafood.

UNIT V
Metabolic functions of hormones.

UNIT VI
Nucleoprotein, nucleic acids, nucleotides, nucleosides.

Practical
Modern methods for analysis of vitamins, minerals and nucleic acids. Organoleptic evaluation of flavours and pigments. Extraction of flavours and pigments and evaluation.

3. FPT 607. Toxins and Contaminants 2(2+0)

Theory

UNIT I
Public health problems due to food borne contaminants.

UNIT II
Factors contributing to outbreaks of food poisoning.

UNIT III
Aflatoxins in fishery products. PAH in smoked fish. Biogenic amines and its significance to human health, Different types of marine bio-toxins such as Ciguatoxin, Paralytic shellfish toxins diarrhetic shell fish toxins, DSP toxins, Scomberotoxins, Brevitoxins, etc. Symptoms, treatment, pharmacology, detection.

UNIT IV
Overview of toxicity of marine animals.

UNIT V
Analytical methods for different types of marine toxins and its tolerance limits: Stability, bioassays, pharmacology assays, immunoassays, Instrumental methods.

UNIT VI
Contaminants of the aquatic environment - Heavy metals (Hg, Cd, Pb, Cr, Ni, As etc.).

UNIT VII
Pesticide contaminants: PCB, organochlorine etc., their source, bioaccumulation, magnification and toxicity. Persistent pollutants. Toxicity evaluation. Measurement of LC and factors affecting LC , Animal tissue 50 50 analysis.

IV. DEPARTMENT OF FISHERIES ECONOMICS

Ph.D. (Fisheries Economics)

Major courses

1. FEC 601. Advanced Economic Analysis 2(2+0)

Theory

UNIT I

Theory of consumer behaviour: concepts, analytical approaches, limitations and applications, demand theory, demand functions. Recent developments in the theory of demand constant elasticity demand function. Utility functions - separable and additive, homogenous and homothetic functions, direct and indirect.

UNIT II

Basic theory of the firm: concepts, production functions, isoquants derivations and applications, optimization behaviour – alternative models, short run and long run cost functions; total price effect-substitution effect, output effect and profit maximization effect, joint products-concepts and constrained optimization.

UNIT III

Extended theory of the firm: homogenous production functions; constant elasticity of substitution production functions-concepts, properties, equilibrium analysis and applications; duality in production, production under uncertainty, linear production functions for single and multi output cases.

UNIT IV

Commodity market equilibrium-short run, long run, differential cost conditions; theory of cost, cost functions, taxation applications. Theory of welfare: - Criteria of social welfare, Determination of welfare maximizing out put-mix, Commodity distribution and resources allocation.

UNIT V

National income, Consumption, Investment Function and Multiplier Price level, inflation, CPI, WSPI, in the economy. The concept of full employment, inflationary gap. Multiplier and accelerator analysis, Monetary and fiscal policies, Taxes and expenditure.

2. FEC 602. Fisheries Marketing and Price Analysis 3(2+1)

Theory

UNIT I

Fisheries marketing definition and scope, functions of fish marketing, Markets and market structure, Government and Co-operative in fisheries marketing , integration, marketing efficiency, marketing cost and price spread, marketing planning, marketing strategy, marketing research, Marketing infrastructure, Marketing regulations, constraints and approaches to fish marketing development.

UNIT II

Supply Chain Management Concepts and Evolution, value addition in fish marketing. Constraints and approaches to SCM in fisheries sector. Vertical integration and its effect on price determination. Domestic and external markets for fisheries products**.** Indian fisheries intervention.

UNIT III

Developing marketing strategies. Advanced studies of marketing information system and e-marketing, fish-business. Dynamics and innovations in fisheries marketing system. Applications of econometric methods of analysis for the study of market behaviours. Market intelligence, its need, analysis and dissemination.

UNIT V

Principles of price determination. Price difference and variability, price analysis, price elasticities, Price determination of fish and fishery products, characteristics of demand and supply of fish and fishery product , supply responses, seasonality, online trading, future trading, price support measures. Price stabilisation policies.

UNIT IV

Seafood and aquaculture markets world-wide, Marketing channels, Economies of scale, Economics of processing, Economic feasibility and Business Plan Development. Policies and regulations that affect aquaculture marketing and distribution. Indian seafood and aquaculture marketing environment.

Practical

Price determination of fish and fishery products, Price difference and variability, price analysis, price elasticities, Price determination, Market integration and marketing efficiency, Case studies of supply chains in urban and rural fish markets, and exported product and domestically traded product. Country Risk Analysis: case studies of comparative risk positions of various countries as export markets for fish products. Export composition and destination of Indian seafood products. Import composition and origin. Analysing trade performance before and after WTO; Analysis of international price trends and volatility; Case studies of seafood export firms. Case studies e-marketing dynamics and innovations in fisheries marketing.

3. FEC 603. Advanced Econometrics 3(2+1)

Theory

UNIT I
Economics, Statistics and Econometrics. Representation of economic phenomenon, relationship among economic variables, linear and non-linear economic models. Regression and Correlation; Partial correlation; The normality assumption (Classical Normal Linear regression Model Nature of Regression Analysis – Simple regression, multiple regression and their assumptions.

UNIT II
Basic concepts of matrix algebra, differentiation, integration and probability distribution theory; Correlation matrix, residual variance, coefficient of multiple correlation, standard errors of co-efficient estimates and their uses in regression, analysis of partial correlation and its uses in interpreting regression co-efficients.

UNIT III
Hypothesis testing, Estimation inference; Ordinary least squares – deriving normal equations, assumptions and properties of OLS; Estimation and interpretation coefficients; Large sample properties – Maximum Likelihood Estimation; Violation of basic assumption of OLS and remedies.

UNIT IV
Multicollinearity, Heteroscedasticity, Autocorrelation, Normality assumption; Use of Dummy Variables – Simultaneous equation model; Time Series Analysis; Basic Econometric Modeling.

Practical
Application of OLS; application of generalised least square; Tests for Multicollinearity, Heteroscedasticity, Autocorrelation, and Normality assumption. Estimation of Economic Parameters.

4. FEC 604. Fisheries Planning and Policies 2(2+0)

Theory

UNIT I
Planning in India-Objectives, allocation, achievements and bottlenecks of Indian plans, Strategy of Indian planning, resource Mobilization.

UNIT II
Fisheries Development and policy under the plans, Fisheries schemes; Centrally and State sponsored schemes. Different sectoral schemes, Agriculture policies, Need for a separate fishery policy. Leasing policies for inland water bodes and brackish water bodies in different states, Input Policy, Financing and Credit Policy, fish marketing and pricing policy, Export –Import Policy.

UNIT III
Types of planning, Stages in the planning process, Planning models. Planning for utilization of surplus resources including manpower.

UNIT IV
Subsidies in Fisheries, regional disparities, poverty and unemployment in India with respect to the fisherfolk. Policies, sectoral study of capture and culture fisheries.

Practical
Performance appraisal of the different sectors over the years; Developing policy framework for the fisheries sector.

5. FEC 605 Advanced Aquaculture Production Economics and Management 3(2+1)

Theory

UNIT I
Production economics- nature and scope, approaches terms and concepts Different production relationship – factor- product, factor - factor, product Farm management. Risk and uncertainty, productions and cost concept.

UNIT II
Mathematical analysis of production relationship – concept of production function, different types, characteristics, economics Implications, economic optimum and physical optimum, decision make with multiple variables.

UNIT III
Decision making with no risk, with risk, Technology, Input use and factor share, Farm business analysis economic efficiency in fish production, yield gap, yield penalties and yield declines.

UNIT IV
Economic aspects of different aquaculture production systems in India and abroad.

Practical

Estimation of the different production relationships, Farm business analysis, mathematical analysis of production relationship, Estimation of physical and economic optimum, Inclusion of risk and uncertainty in aquaculture systems, Incorporation of technology as a component in the production function, Estimation of yield gap and factor shares.

6. FEC 606. Advanced Marine Resource Economics 2(1+1)

Theory

UNIT I

Marine Capture fishery resources – cost concepts applied to capture fisheries – economic analysis of fishing – production function in marine capture fisheries. Introduction the economics of Fisheries Management – Commercial fisheries as a system – Management of Fisheries – Rational fishery management – Management Planning – Goals and Policy objectives – strategies.

UNIT II

Brief review of the basic concepts of Fisheries Management – Biological aspects, economic aspects and social considerations – Constraints under which small-scale fisheries operate – likely effects of human interventions.

UNIT III

Biological, economic and social aspects of multispecies fisheries management – increase of fishing effort – Consequences of innovations, subsides and changes in fisheries costs and the value of yields – Regulation of fishing effort and control of catch capacities – economic mechanisms for the control of fishing.

UNIT IV

Key issues for fisheries management and development – objectives, policies and strategies for fisheries development – principles and techniques of fisheries management. Strategies for sustainable marine capture fisheries development

Practical

Economic analysis of marine fishing – estimation of production function for marine capture fisheries – resource use studies in marine capture fisheries – experts review on the measures of fishery regulations – Discussion on Strategies for sustainable marine fisheries development.

Minor courses

1. FBM 507. Managerial Economics 2(1+1)

Theory

UNIT I
Introduction to managerial economics: Microeconomics, Macroeconomics, Demand analysis - types of demand, determinants of demand; elasticity of demand. Analysis of costs - nature of costs, cost-output relationship in short and long term, profit maximization.

UNIT II
Theory of production - production function, laws of production; laws of returns, returns of scale, economies of scale. Production relationship: factor-product, factor-factor and product-product.

UNIT III
Market structure and price determination; perfect and imperfect competitions. Monopoly, price discrimination; monopolistic competition and oligopoly.

UNIT IV
Types of economy, Measuring performance of the economy. Consumption, saving and investment function. Income and employment determination. Aggregate demand and supply, general equilibrium; multiplier.

UNIT V
Money - functions of money, theory of money and price, Inflation, Balance of payment and Exchange rate.

Practical
Demand - supply relationship. Elasticity - price, income, cross. Exercises in factor-product, factor-factor and product-product relationships. Production costs and their relationship, Break-even point, National income accounting. Multiplier. Inflation. Case studies on different micro and macro-economic variables in fisheries sector.

2. FBM 608 Finance and Accounting for Managers 2(1+1)

Theory

UNIT I

Overview of Financial management, Financial systems, Financial statements, taxes and cash flow, Analysing financial performance, Break even analysis and leverage, Time value of money, valuation bonds and stocks, Risk and return, Capital budgeting, techniques of capital budgeting, Cost of capital, Sources of long term finance, Dividend decisions, Debt analysis and management, Leasing hire purchase and project finance, Inventory management, Working capital management,, merger, acquisitions and restructuring Stock exchange, Mutual fund ,Banking systems.

UNIT II

Accounting: Theoretical concept of accounting, Meaning and scope of accounting, accounting principles, journalising transactions, ledger posting and trial balance, negotiable instruments, Final accounts, Depreciation provisions and reserves, single entry systems double entry system, inventory valuation, joint stock company, shares and capital, debentures, management accounting: nature and scope, financial statements analysis and interpretation, ratio analysis, classification of ratios, fund flow and cash flow statements.

Practical

Case studies and practicals on financial management and accounting, Familiarisation and application of Tally software.

3. FBM 609. Entrepreneurship Development 2(1+1)

Theory

UNIT I

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. Overview of aqua inputs and fish processing industry.

UNIT II

Concept of entrepreneurship; entrepreneurial characteristics; managerial skills and risk taking behaviour; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up in entrepreneurship; managing competition development; entrepreneurship development programmes; Generation, incubation and commercialization of ideas and innovations. Role and promotion of leadership, collective action and stakeholder cooperation.

UNIT III

Project, project cycle, project formulation, monitoring and evaluation methods - NPV, BCR and IRR; Guidelines for project formulation.

UNIT IV

Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Venture capital. Contract farming. Social Responsibility of Business.

Practical

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

V. DEPARTMENT OF FISHERIES ENVIRONMENT

Ph.D. (Aquatic Environment Management)

1. AEM 601. ADVANCES IN AQUATIC ENVIRONMENTAL STUDIES (2+1)

Theory

UNIT I
Factors effecting productivity of aquatic ecosystems and their interactions; phosphorus, nitrogen and silica cycles; minor metallic elements; organic matter in lake waters. Dynamics of flowing water; Indices of productivity; pollution index – usefulness and limitations.

UNIT II
Eutrophication – causative factors, effects on water quality, fish and other biota; measures to control the lake degradation due to eutrophication.

UNIT III
Biomanipulation: Concept and approaches- studies on Planktivorous,Benthivorous and Omnivorous fish. Biological control of macrophyte and eutrophication.

UNIT IV
Biomonitoring of aquatic environment, scope and process; Bioindicator organisms and their Characteristics; Assessment of water quality through bioindicators.

UNIT V
Global warming and green house effects- process and impact on aquatic environment; Integrated environment management (IEM), Role of human element in IEM, Analytical Behavior Analysis Approach (ABAA) for IEM.

UNIT VI
Natural disasters: formation, causes and effects; effects on aquatic habitat and coastal population; Concerns and management; mitigation process; preparedness, Anthropogenic activities leading to environmental disasters. Man-made aquatic environmental degradation; effects on aquatic life.

Practical
Analysis of ions; Calculation of shoreline development index and other indices of lake productivity; Studies on eutrophication in natural waterstanks and ponds; Collection, preservation and estimation (quantitative and qualitative) of bioindicator organisms in polluted water. Demonstration of Biomanipulation experiment; Preparation of disaster kits for coastal fisher; Interaction of the Govt. and Non-Govt. Organizations engaged for disaster management.

2. AEM 602. BIOTECHNOLOGY FOR CLEANER ENVIRONMENT (1+1)

Theory

UNIT I

Pollution Control: Cleaner technologies, Reducing environmental impact of industrial effluents, **Toxic site reclamation.**

UNIT II

Microbial transformation of toxic metals, Removal of spilled oil and grease deposits, 'Biorational' or 'Environmentally Safe' weed and pest control, Bio-fertilizers, Bio-sensors and biochips to detect environmental pollutants.

UNIT III

Application of biotechnological tools in biomonitoring of aquatic environment; Renewable or bio-energy and bio-fuels from aquatic environment, Energy and fuel production using micro-organisms; Production of food: Single cell protein, Algal biotechnology for production of food; Use of microbes for improving soil fertility, biodegradation.

UNIT IV

Biodiversity and its conservation: Current levels of biodiversity, alpha, beta biodiversity, i*n situ* and *ex situ* conservation-gene banks, species conservation.

PRACTICAL

Gel electrophoresis; Total DNA isolation; Separation and detection of fragments, Comet assay, Micronucleus test, Sister Chromatid exchange; Assessing the molecular and cellular level changes in the Aquatic organisms; Genomic libraries and the development of species specific probes. Southern hybridization; RFLP analysis, PCR mechanics.

3. AEM 603 BENTHIC ECOLOGY (1+1)

Theory

UNIT I

Benthic habitat- rocks, reefs, marshes and sediments that form the habitat; recycling of nutrients and the burial and storage of organic matter.

UNIT II

Community ecology; Physical, chemical and biological factors effecting benthic population; abundance and distribution of benthic communities of major groups- their life cycles, food and feeding habits and ecological significance; Role in maintaining ecological balance; Recruitment dynamics; Predator prey interaction; Invasive species.

UNIT III

Human impacts; modification of coastal habitats, and major alterations of biogeochemical cycles; contaminants; Benthic organisms as pollution indicators and biomonitors.

UNIT IV

Use of benthos in environmental impact assessment- case studies-useful biodiversity indices using benthos in EIA.

PRACTICAL

Collection and analysis of soil and water of nearby benthic habitat; collection, identification and preservation of macro and meiobenthos; study of food and feeding habit of some benthic population. Quantification of benthic faunal changes in polluted waters

4. AEM 604. ESTUARINE AND COASTAL DYNAMICS (2+1)

Theory

UNIT I
Definition of an estuary; Buoyancy input as freshwater.

UNIT II
Dynamics of the gravitational circulation; Mixing of fresh and salt water; Sources of energy for mixing. Estuarine circulation, Richardson number. Contributions to the salt flux.

UNIT III
Simplified salt balance using the steady state salinity distribution to predict the concentration of a pollutant. Freshwater fraction. The flushing time of an estuary and methods of determining it.

UNIT IV
Waves in shallow waters, transformation, refraction and reflection; Mass transport. Return flow. Rip current. Long shore currents. Momentum balance.

UNIT V
Sediment transport. Base studies on sedimentation in Estuaries effects of man –made structures and breakwaters on coastal sedimentation. Standing waves and harbor resonance.

Practical
Measurement of tidal currents in estuaries - analyses of tidal heights – Net flow and residence time computations. Computation of salt and nutrient flux. Construction of wave refraction diagrams. Computation of long shore currents and sediment drift beach profiles.

5. AEM 605. ORGANIC PRODUCTION AND PLANT PIGMENTS (2+1)

Theory

UNIT I
Concepts of production; measurements of rate of production – oxygen technique, radiotracer technique (C14), in-situ measurements.

UNIT II
Phytoplankton production in an isolated, non isolated communities in flowing and standing waters, measurement of rates of production from changes in phytoplankton biomass.

UNIT III
Measurement of photosynthesis under laboratory conditions; factors regulating aquatic production; The role of Enzymes in relation to photosynthesis; The photosynthetic pigments, their location in the chloroplast, The role of accessory pigments during photosynthesis; Molecular organisation of chlorophylls, phycobilins and carotenoids; Pigment degradation products – phaeopigments – phaeophytin and phaeophorbides.

UNIT IV
Chloroplast – structure and function of grana and lamellae. Structure of chloroplast membrane – in relation to energy coupling and transport.

UNIT V
Application of remote sensing in studies on chlorophyll and other pigments.

UNIT VI
Production rates – direct measurement of zooplankton reproduction – marking populations. Laboratory measurements of physiology of zooplankton – feeding, respiration and excretion.

Practical
Estimation of primary production in waters –by radioactive carbon C14 technique. Laboratory studies to understand the impact of nutrients and light on primary production using selected algal cultures. Laboratory studies on the oxygen consumption, filtration and grazing by selected zooplankters. Collection of water samples from selected aquatic environments for the estimation of different plant pigments – chlorophylls and carotenoids; Estimation of pigments in some of the selected aquatic weeds.

6. AEM 606 ENVIRONMENT IMPACT ASSESSMENT (1+1)

Theory

UNIT I
Environmental Impact Assessment (EIA): Process, evaluation and methodology; Social Impact Assessment (SIA) as a part of EIA-principals and process; EIA of aquacultural projects, coastal industries and other developmental activities.

UNIT II
Environmental audit: Concept, setting up an audit programme, typical audit process, carrying out the audit, benefits of environmental auditing, Environmental audit programme in India.

UNIT III
International and national environmental protection standards; Environmental quality monitoring; ISO-14000-Environment Management System (EMS)-present status; Impacts on developing countries.

UNIT IV
Legal issues and environmental Impact Act – acts & legal issues related to aquatic environment protection – National Aquatic invasive species act, clean water act, Implementation of the act, Agencies involved in implementation - Guidelines for implementation and management.

UNIT V
Voluntary guidelines for consideration of biodiversity in EIA.-Strategic Environmental Assessment-biodiversity issues at various stages of EIA.

UNIT VI
Case studies one each for freshwater, estuarine and coastal areas

PRACTICAL
Field visits for EIA and SIA of certain aquacultural projects; EIA report preparation; Environmental audit programme.

7. AEM 607. MANAGEMENT AND UTILIZATION OF WASTEWATER (2+1)

Theory

UNIT I

Advance treatment methods-Principles and procedures; ozonation, U.V. irradiation etc; Oxidation of sediment; Aerobic and anaerobic treatment process; Role of aquatic macrophytes in biological treatment of waste water; Wastewater treatment through the use of solar energy; Basic design of water and wastewater treatment plants. Removal of nitrogen and phosphorus from wastewater.

UNIT II

Waste recycling and waste management in aquaculture; Design and construction of water filtration devices; Utilization of wastewater for mass cultivation of algae and other fish food organisms; Utilization of waste water for aquaculture and Agriculture.

UNIT III

Waste disposal criteria used in different parts of world - national and international standards; Production of biogas from sewage; Advances in Pollution prevention, Environmental management.

Practical

Estimation of physico-chemical characteristics of wastewater. Estimation of nutrients and contaminant of wastewaters. Analysis of living communities associated with treatment processes; Demonstration of wastewater treatments (ozonisation, chlorination, aeration, precipitation, coagulation etc.). Utilization of wastewater - Processing and characteristics of sludge, utilization of coastal sludge for aquaculture, Treatment of fish meal plant wastewater and its utilization, utilization of different wastewaters for mass culture of algae, live fish food organisms and mass culture of duckweed.

8. AEM 608. RESTORATION ECOLOGY (1+1)

Theory

UNIT I

Ecological restoration- Need, concept and definition; Approaches; Rationale for restoration; Differences between conservation and restoration; critical ranges of variability in biodiversity. Restoration of habitat like coral reef, sea grass, mangroves etc.

UNIT II

Ecological processes and structures, regional and historical contexts, and sustainable cultural practices; Ecosystem integrity; community ecological principles; Disturbance, Succession, Fragmentation, Ecosystem auditing; Ecosystem function.

UNIT III

Emerging concepts-Assembly, Stable states; Biotic and abiotic flows and cultural interactions; Application of theory-Invasion, competitive dominance and resource use; IV Restoration planning; Wetland assessment, Delineation, and regulation; Recovery process, Mitigation, Rehabilitation and Reclamation; Dynamics and restoration of degraded wetlands; Removal of threats to the health and integrity of the restored ecosystem.

UNIT IV

Individuals participation in a restoration programme; different human participatory programme; Sustainable cultural practices; constraints and opportunities; Economics of selective habitat restoration.

PRACTICAL

Collection and segregation of native and non native species from a damaged environment; Making list of historical and cultural interactions; Status of assemblages; calculation of Index of Biotic Integrity; Listing of the threats to the integrity of the ecosystem; Organizing different participatory programme.

9. AEM 609. DISPERSAL AND FATE OF POLLUTANTS IN THE OCEAN (1+1)

Theory

UNIT I
Common transport processes of pollutants in the ocean.

UNIT II
Influence of winds, tides, Waves and currents on the dispersal of pollutants, mixing due to waves and Wave induced currents; Principles of design of marine waste disposal system.

UNIT III
Pollutant dispersion in coastal waters and estuaries, dispersion near outfall sites; Methods of pollutant dispersal dye diffusion studies.

UNIT IV
Ballast Water Management (BWM) Convention, BWM guidelines, BWM treatment system, BWM Technology, BWM to combat invasive species.

Practical
Techniques of computation of dispersion coefficients; Calculation of Richardson number, tidal exchange calculation at the estuarine mouth; Numerical analysis of estuarine dispersion; Simple plume experiments – designs of waste discharge and thermal systems.

VI. DEPARTMENT OF FISH QUALITY ASSURANCE AND MANAGEMENT

Ph.D. (Fish Quality Assurance and Management)

1. FQM 601. Enzymes in Fish Quality (2+1)

Theory

UNIT 1
Postmortem changes in fish - Nucleotide degrading enzymes – ATP related compounds, factors affecting ATP degradation; ATPase, AMP deaminase, 5' Nucleotidase, Nucleotide phosphorylase, Xanthine oxidases- Mechanisms of spoilage of proteins, carbohydrates, lipids, and their impact on fish quality and safety.

UNIT 2
Muscle proteins – classification, structure, contraction; Myosin – Functions- ATPase activity, actin binding and thick filament formation; Implications on processing – Instability, prevention of denaturation

UNIT 3
Proteinases – Acid/aspartyl – pepsin, chymosin, gastriscin, Serine – trypsin, chymotrypsin, elastase, collagenase; Thiol/cysteine – cathepsin B, Metalloproteinases – Types, properties and applications

UNIT 4
Lipid degrading enzymes – Lipases – lipoprotein, hepatic, pancreatic, gastric; Fish lipases; Lipases in seafood; Phospholipases A1, A2 and C; Fish phospholipases; Phospholipase activity in fish postharvest technology

UNIT 5
Enzymes affecting fish texture - Endogenous enzymes – cathepsins, calpains, transglutaminases; Cathepsins – Types B. L, L-like and Cystatins, properties, autolysis, tenderization, sources, effects on rigormortis, tenderization, gelation, softening, surimi processing

UNIT 6
Enzymes affecting seafood flavour – Aroma biogenesis - Lipoxygenases – occurrence in fish, chemical structure, mode of action, properties, significance in flavour formation

UNIT 7
Spoilage enzymes – TMAO degrading enzymes – ATP degrading enzymes- distribution, physiological significance – factors affecting distribution – degradation products; Polyphenol oxidase - Melanosis – enzyme characteristics, economic losses, biochemistry, control measures – processing and inhibitors.

UNIT 8

Application of fish enzymes in food – Speciality products – mince, PUFA enriched oils, caviar, cured fish, protein hydrolysates, seafood flavourings, fish sauce; Fish Processing aids – Deskinning, descaling, membrane removal

UNIT 9

Enzymes as Quality Indices – ATPase, Lactate dehydrogenase, Lysosomal and mitochondrial enzymes

Practicals

Measurement of ATP degradation products – Hypoxanthine and K value, Fish myosin isolation, Isolation and purification of fish pepsin by ion exchange chromatography; Isolation and purification of trypsin by ammonium sulphate precipitation, gel filtration and affinity chromatography; Extraction of transglutaminase; Study of black discoloration in shrimps; Tenderization of fish meat using enzymes; Descaling process using enzymes; Assay of ATPase activity.

2. FQM 602. Fish Authentication and Traceability (2+1)

Theory

UNIT 1
Seafood authentication – Seafood fraud – Types of fraud – Transhipment, overtreatment, mislabelling, and colour alteration

UNIT 2
Mislabelling – Species substitution – Low valued fish, Geographic origin, Genetically modified fish – Food safety issues and regulations

UNIT 3
Methods of detection – DNA based methods – DNA sequencing and Non – DNA sequencing; RFLP, AFLP, RAPD, satellite DNA, SSCP, DGGE, selective amplification, quantitative PCR, multiplex PCR, microarray, high – throughput assay; Instrumental methods – NMR

UNIT 4
Foreign protein adulteration – protein based methods – electrophoresis and immunological

UNIT 5
DNA bar-coding – Species substitution, detection – mini barcodes; Databases – Fish Trace, Fish Gen, AFLP, validation, Fish DB, RFE, etc

UNIT 6
Bioinformatics in fish industry – its applications; bioinformatics related to genomics, proteomics, or metabolomics

Practicals

Study on the types of seafood fraud in International and National seafood trade; Detection of colour adulteration in seafoods; Identification of fish species substitution by RFLP; Fish species authentication by AFLP; Creation of data base for fish species by DNA sequencing method; RAPD technique for species identification; SDS-PAGE method for raw and cooked species identification; DNA-bar coding; Analysis of fish trace databases.

3. FQM 603. Global Legislation for Fish Safety and Quality (2+0)

Theory

UNIT 1
Introduction to global legislation, Role of codex, WTO redressal mechanism, GATT, SPS Agreements, Regulations on IUU fish catch, Traceability

UNIT 2
EU legislation –Regulations of food safety issues – Directive conditions – Decisions on importations – Legislations related to fishery products

UNIT 3
US legislation – Four Acts of food safety issues – Food safety hazards – Sustainable Fishery Act - Legislations related to fishery products- Food safety modernization Act

UNIT 4
Important private regulations – ISO, BRC, FSSC, GFSI, SQF

UNIT 5
Canadian legislation – Fish Inspection Act – Freshwater fish marketing Act - Legislations for fishery products

UNIT 6
Australian legislation – Fisheries Act – Fisheries Management Act - Legislations for fishery products

UNIT 7
Japanese legislation – Guidelines for fish – Food sanitation law – Specifications, standards and testing methods

UNIT 8
Indian legislation – Food Safety and Standards Authority of India – Food Laws - Export inspection Council.

4. FQM 604. Nutraceutical Quality of Marine Foods (2+1)

Theory

UNIT 1
Nutraceutical quality of fish and shellfish – chemical composition – minerals, extractives, lipids and sterols

UNIT 2
Marine lipids – nutritional aspects, dietary intake, health benefits; Nutraceutical lipids – food applications. Fish body oil, fish liver oil, seal blubber oil, microalgae oil

UNIT 3
Omega-3 fatty acids – Properties – thermal and rheological; Concentration of omega 3 fatty acids – chromatographic, supercritical, low temperature crystallization, distillation, enzymatic, solubility differences, urea complexation, enzymatic methods

UNIT 4
Fish processing discards - Fish protein hydrolysates – collagen and gelatin – bioactive peptides – Enzymatic production – Food processing and gastrointestinal digestion – potential health benefits

UNIT 5
Marine algae – carotenoids – Phycobilins, polysaccharides, polyphenols, sulphated polysaccharides – Structure, occurrence and functional properties

UNIT 6
Chitin and chitosan – chitosan oligomers – glucosamine, chontroitin sulphate, squalene – functional benefits and food applications

UNIT 7
Functional activities – antioxidative, hypolipidemia, hypocholesterolemia, immune modulatory, anti-cancer, anti-microbial, anti-arthritic, anti-obesity, and hepatoprotective properties

Practicals

Extraction of important extractives from fish; Analysis of health beneficial omega – 3 fatty acids from different seafoods; Nutritional requirement for omega-3 fatty acids and dietary intake; concentration of omega-3 fatty acids by urea complexation and enzymatic methods; Collagen preparation; peptide purification; Chitooligosaccharides and glucosamine preparation; Carotenoid preparation; Antioxidative assays – DPPH, ABTS, FRAP, metal chelating properties, reducing power, superoxide anion scavenging assay; antimicrobial assays; anti-arthritic assays; anti-cancer assay; Functional properties – viscosity, gelation, water holding capacity, fat binding capacity, foaming ability, etc.

5. FQM 605. Pathogenicity of Seafoodborne Pathogens (2+1)

Theory

UNIT 1
Pathogens – Gram-positive bacteria - cell wall and cytoplasmic membrane; Gram negative bacteria – outer membrane, periplasmic membrane, protein secretion system, endospores; Viruses – structure – types of viruses; Parasites – Types

UNIT 2
Pathogenesis mechanisms – Infective dose, host pathogen interaction, molecular pathogenesis, molecular mechanism, mode of action, intracellular growth; Specific virulence factors – adhesion – fimbrial and non fimbrial, biofilms, colonization factors, invasion factors, capsules and other surface components

UNIT 3
Intoxications – Toxins - endotoxins – structure, biological activity, detection – Genetic regulation and secretion systems of virulence factors – pathogencity islands, protein secretion systems, regulation of genes; exotoxins, siderophores; Epilogue

UNIT 4
Specific seafood borne pathogens – *Staphylococcus aureus* – Virulence factors, enterotoxins, molecular regulation, pathogenesis

UNIT 5
Clostridium – pathogenesis, toxins, genetic regulation

UNIT 6
Listeria monocytogenes – Pathogenesis – intestinal phase of infection, attachment, entry, phagosomes, intracellular growth, cell-to-cell spread, regulations

UNIT 7
Escherichia coli – Serotypes and virotypes, pathogenesis, virulence factors, regulation- Role and significance of indicator organisms in fish safety

UNIT 8
Salmonella – pathogenesis, pathogenecity islands, type III secretion system, adhesion, colonization, phagocytosis, regulation

UNIT 9
Vibrio cholerae, Vibrio parahemolyticus and other *Vibrio* spp. - pathogenesis, toxins, hemolysin immune response

UNIT 10
Aeromonas hydrophila - pathogenesis, virulence factors, toxins, mode of infection, associated diseases

Practicals

Clinical, histological and microscopical techniques - Animal model to study foodborne human pathogen interaction; Cell culture – cell lines, selection, isolation, performance - Measurement of virulence; Measurement of specific steps in colonization and invasion; Serological and immunological techniques – scientific basis, immuno diagnosis, antibody detection; Molecular diagnosis- scientific basis, nucleic acid hybridization, PCR diagnostic techniques, Real-time PCR, Microarray.

6. FQM 606. Instrumental Fish Quality Analysis (1+2)

Theory

UNIT 1
Introduction to physical quality testing of fishery products; Different methods; Dielectric properties – fischtester, torrymeter

UNTI 2
Vis/NIR spectroscopy – Principle and assessment of constituents, freshness, safety and authentication

UNIT 3
Differential scanning calorimetry – Principle and assessment of fish quality and safety. Colour measurement – instrumentation, methods of colour evaluation, colour measurement in fish

UNIT 4
Texture measurement – muscle structure, quality prediction; Image processing – quality characteristics, spectral signatures, elastic properties – freshness and firmness determination

UNIT 5
NMR spectroscopy – chemical composition, finger printing and authentication; Two dimensional gel electrophoresis – protein studies

UNIT 6
Flavour active compounds – Desirable fresh flavours, pre and post harvest taints - Distillation and solvent extraction, headspace analysis, gas chromatography, mass spectroscopy

UNIT 7
Biosensors - seafood aroma – Sensor array technology – different types of sensors- chemical and physical sensors – Applications – Advantages and disadvantages

UNIT 8
Hygiene monitoring system – Rapid instrumental methods in testing microbial quality and safety of fish – Detection of toxins by mass spectrometry

UNIT 9
Machine vision, electronic nose and electronic tongue. SEM – Micro-structure analysis, elemental analysis, foreign objections detection

Practicals

Analysis of fish using RT fish tester based on dielectric properties; Fish constituent analysis by Vis/NIR spectroscopy; Hardness measurement by universal testing machine; Texture analysis by different probes; 2D gel electrophoresis of fish proteins; Interpretation of NMR spectral data to predict authentication; Analysis of flavour volatiles by gas chromatography; Interpretation of mass spectral data for prediction; Scanning electron microscopy of the fish structure and their interpretation.

7. FQM 607. Toxicology of Chemical Residues of Fish (2+1)

Theory

UNIT 1
Introduction – Genetic toxicology – types, Chromosomal change, human genetic damage; Carcinogenicity – forms of cancer, Mechanisms

UNIT 2
Reproductive toxicity – Classification of chemicals, directives, effects on fertility, developmental toxicity, lactation

UNIT 3
Immunotoxicology – Types of immunity, hypersensitivity, immunodeficiency, autoimmunity, transplants, vaccination; skin toxicology – potency, dermatitis, UV radiation, peroxisomes

UNIT 4
Respiratory toxicology – lung damage, asthma, lung cancer; Hepatotoxicity – mechanism of cellular injury, pattern of response, detection

UNIT 5
Nephrotoxicity – toxic nephropathies, metal toxicology, mycotoxins, pesticide

UNIT 6
Neurotoxicity; Radio nuclides – Types, interaction with biological effects; rates of exposure, metabolism

UNIT 7
Biocides and pesticides – Types, organochlorine, organophosphate, carbamates, insecticides – nicotinoids, pyrethroids. Fungicides, herbicides, rodenticides – mechanism of action, biomarkers

UNIT 8
Pharmaceutical toxicology – Pharmacokinetics, pharmacodynamics – Anaesthetic, antibiotic, antihistamine, antiviral, immunosuppressive agents – mechanism of action.

UNIT 9
Fish allergens – Fish and Shellfish – Parvalbumins – Symptoms, cross reactivity, sensitive individuals –treatments - detection methods – labeling laws

Practicals

Sample collection for toxicological assays. Genetic toxicity tests. Carcinogenicity tests by cell culture technique. Microarray in toxicology. Testing of pesticides residues. Testing of different antibodies in shrimps. Testing of selected antioxidants by HPLC. Estimation of various food additives. Testing of heavy metals like cadmium, mercury, lead, copper and zinc by ICP-MS.

8. FQM 608. Safety of Aquacultured Products (2+1)

Theory

UNIT 1
Introduction – Aquaculture products –Food Safety issues – Hazards and Risks

UNIT 2
Biological hazards – Parasites, pathogenic bacteria, viruses and other biological toxins

UNIT 3
Chemical hazards – Agrochemicals- fertilizers, disinfectants, oxidizing agents, flocculants, osmoregulators, pesticides, herbicides, algicides, fungicides, antioxidants; veterinary drugs – antibiotics, growth promoters, probiotics, prebiotics and other feed additives- antimicrobial agents – residues in edible tissues- human health considerations

UNIT 4
Environmental hazards – biological, organic, chemical pollutions; habitat modifications; Metals from soil, industrial wastes, sewage and manures; antifoulants

UNIT 5
Strategies for food safety assurance - Risk assessment, application of the HACCP to aquaculture practices- site selection, water quality, feed supply, production, verification procedures, record keeping unit

UNIT 6
Standards for aquaculture products - Ban on Indian aqua products; Emerging zoonotic diseases, genetically modified fish – diagnosis, food safety issues

UNIT 7
Knowledge gaps and research needs in chemical and biological hazards; Strategies for management and control - Shared responsibility, Food safety assurance, Safe food processing, Food safety education, Safe use of chemicals in aquaculture

Practicals:

Detection of bacterial pathogens in aquacultured products – *Aeromonas hydrophila*, *Vibrio* spp., *Pseudomonas*, etc; Screening for the different viruses in aquacultured products – WSSV, YHV, IHHNV, TSV, etc; Detection of chloramphenicol, nitrofurans, ethoxyquin by LC/MS/MS, Analysis of resistant microflora in shrimps, Detection of environmental pollutants by ICP-MS.

VI. DEPARTMENT OF FISHERIES EXTENSION

Ph.D. (Fisheries Extension)

1. FEX : 601 ADVANCES IN FISHERIES EXTENSION MANAGEMENT (2+1)

Theory

UNIT I

Approaches of Fisheries and Aquaculture Extension: A critical analysis of different approaches; Extension programmes of corporate sector, the concept importance and implications of livelihood extension, Technology Base of Aquaculture Extension : Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system with formation research, Agricultural Knowledge and Information System (AKIS); significance of theories of social learning for extension practice; Cyber Extension: Concept of cyber extension, national and international cases on extension projects using ICT and their impacts.

UNIT II

Economics of Fisheries and Aquaculture extension: National investments in extension, impacts of fisheries / aquaculture extension, alternative methods of financing fisheries / aquaculture extension, privatization of fisheries / aquaculture extension – scope, limitations and experiences and cases; Implications of GATT agreement for extension services, reorientation of extension services for agri-business and marketing activities, GOI-NGO collaboration to improve

UNIT III

Efficiency of extension. Extension and contemporary issues: issues related to rural poverty, environmental protection of farm and home, bio-diversity, sustainable development, food and nutritional security, recent advances in biotechnology. Analysis of ITK system, cases on integration of ITK and formal research; Analysis of cases on cyber extension and privatization of extension: pattern and success stories.

Practical

Critical analysis of the management aspects. Study and preparation of case material on selected dimensions of management through visits to various fisheries development organ

2. FEX : 602 MONITORING AND EVALUATION OF DEVELOPMENT PROGRAMMES (2+1)

Theory

UNIT I

Monitoring, evaluation and impact assessment - importance and scope in fisheries programmes; conceptual frameworks, results frameworks and logic models; Quantitative and qualitative indicators – characteristics and their selection criteria; indicators and information systems for sustainable fisheries development - testing and improving indicators; Integration of M and E systems into development programmes.

UNIT II

Difference between outcome and impact; Types of impact assessment : Climate impact assessment; Demographic impact assessment; Development impact; assessment; Ecological impact assessment; Economic and fiscal impact assessment; Environmental auditing; Environmental impact assessment; Environmental management systems; Health impact assessment; Project evaluation; Public consultation; Public participation ;Risk assessment; Social impact assessment; Strategic impact assessment; Technology assessment, Equality impact assessment.

UNIT III

Impact assessment methods: Types-Within-without; Before-after; Case study; Participatory; Social Auditing; Steps: Quantifying the impact parameters; Identification of data sources and their types; Sampling design; Data generation; Analysis; Report writing

Practical

Development of M and E plan and procedures for fisheries using participatory approach. Preparing M and E plan for some fisheries programmes. Developing indicators and information system for sustainable fisheries development. Analysis of different reports, conducting impact assessment exercises, case studies.

3. FEX : 603 MEASUREMENT AND SCALING TECHNIQUES IN FISHERIES EXTENSION (2+1)

Theory

UNIT I

Measurement - concept, importance, levels and their properties; Reliability: concept, importance, types - split half, parallel form, test-retest reliability; interpretation of reliability coefficients; Validity: concept and types - content, criterion related, construct, concurrent and predictive validity.

UNIT II

Development and standardisation of tests and scales - knowledge test, types of time test; Difficulty index, discrimination index, point biserial correlation and scoring; Item analysis: concept and use in behavioural research; interpretation of research data; Intelligence tests: definition, types and scoring method; Projective tests: Thematic Apperception Test, Rorschach's ink plot test, words association test, etc.

UNIT III

Content analysis - method and scope; Critical incident technique – method and application; Sociometry – concept, types like sociogram, sociometric indices and matrices, their applications; Semantic differential technique; Psychometric analysis; Q Methodology; H-Technique.

UNIT IV

Scaling techniques; concept, construction and use of attitude statements; Method of Paired Comparison - Thurstone's Contribution, development of scale with 'F' 'P' and 'Z' Matrices, calculation of scale values, tests of significance, administration and scoring; Method of Equal Appearing Intervals - rational, development, sorting procedures, calculation of scale and 'Q' values, administration and scoring; Method of Successive Intervals - rational, development, estimating intervals widths, determining scale values, internal consistency check, administration and scoring; Method of Summated Rating - rational, development and procedure for selection of items, interpretation of 'T' scores and administration.

UNIT V

Scalogram Analysis – rational, unidimensionality of the scale, Cornell technique and other methods of scalogram analysis, coefficient of reproducibility, scale and non-scale types and their administration; Scale Discrimination Technique - development of this technique, obtaining scale and 't' values and advantages of scale discrimination technique.

UNIT VI

Non-Parametric Tests - meaning and types, one sample runs test of randomness, sign test, wilcoxon signed rank test, wilcoxon-Mann-Whitney test, Cochran Q test, Spearman rank order correlation coefficient, Kendall rank order correlation coefficient and Kendall's coefficient of concordance.

Practical

Exercises on measurement and frequency distributions. Problems on reliability and validity and interpretation of the results. Problems on transformation of scores. Exercises on difficulty index, discriminant on power. Exercise on point biserial correlation. Exercises on interpretation of scores correlation coefficients and its interpretations. Interpretation of multiple correlation coefficient (R) and R2. Interpretation of path coefficients, direct and indirect effects, etc. Discriminant function analysis - Results and Interpretation; Review of techniques and other procedures including scales developed with special reference to Extension Education research. Assignments for different scaling procedures based on the class discussion by using the hypothetical or actual data. Practical exercises on how to compute reliability and validity measures for test scores. Method of paired comparison. Method of equal appearing intervals. Method of successive intervals. Method of summated ratings. Scalogram analysis. Scale discrimination technique; Exercises on Non-parametric tests.

2. FEX : 604 EXTENSION SERVICE SYSTEM MANAGEMENT (1+1)

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Theory

UNIT I

Meaning and scope of extension service system and its management; Public administration and bureaucracy - concepts, origin and development; Marxian, Weberian and Gandhian thoughts on bureaucracy; bureaucratic vs. developmental organisation.

UNIT II

Processes of management- POSDCORB; Structure, organisation, function, working and management of public extension service agencies like DoFs, FFDA, BFDA, MPEDA, NFDB, NABARD, Fisheries Development Corporations, State Fish Seed Development Corporations, KVKs, SAUs, Fisheries Co-operatives, international agencies, corporate sector, private organizations and MNCs.

UNIT III

Delegation of power, autonomy and organisational communication and conflicts in governmental, UN agencies, non-governmental and private extension service organisations; Conflicting roles and responsibilities of extension agents.

UNIT IV

Organisational communication – meaning, methods, types and techniques; functions and importance in motivation and control; formal and informal communication networks in GOs, NGOs and POs; behaviour of individuals in organisations; Organisational change and communication; patterns of communication of organisational communication; managing organizational communication in fisheries sector.

UNIT V

Research, extension and client systems linkages; linkages and coordination between Dept. of Fisheries and other line Depts. like Irrigation / Water Resources, Environment, Forestry, Agriculture at grassroots, District, State and Central levels; HRD policy in governmental, non-governmental and private extension service organizations. Strengthening governance - transparency, accountability and people's participation.

Practical

Case study and analysis of State Departments of Fisheries in selected States; Case studies in structure organization, staffing, career advancement, quality of service delivery at grassroots level in governmental, nongovernmental and private extension service organisations like DoFs, FFDA, NABARD, State Fish Seed Development Corporations, KVKs, Fisheries Co-operatives, NGOs, and private sector organisations; Study of patterns of communication and effectiveness of Fisheries Development Organisation; Study visit to DoF, Maharashtra, NGOs, NABARD, private sector agencies involved in fisheries extension.

5. FEX: 605 ADVANCES IN TRAINING METHODS AND EDUCATION TECHNOLOGY (1+1)

Theory

UNIT I

Training tools: Expectation setting, Course design, Icebreakers, climate setting and team building exercises, Monitoring and evaluation, Follow up. Commodity System Assessment Methodology: Formation of interdisciplinary team; Developing preproduction, production, post harvest, marketing and service delivery strategies; Workshops: Coordination committee; Expected output; Institutional support; baseline document; Resource persons; Selection of participants; Developing workshop agenda; Conducting the workshop.

UNIT II

Collection of missing information; Checklist for organizing a workshop; Training Manual-Documenting Good Management Practices: challenges, emerging knowledge; Indigenous knowledge, synthesis.

UNIT III

Distance Learning: Identification of potential learners; Defining learning objectives; Designing learning materials; marketing; Implementation; Monitoring and evaluation; Designing programmes for community radio; Farmer field school: Origins of the Farmer field school; Description of a typical Farmer field school; FAO support for Farmer field schools in Asia; Costs and benefits of the Farmer field school.

UNIT IV

Teaching and learning process in extension education. Its characteristics, steps in extension education process, setting up of learning situation, guides to effective extension teaching; Recent research findings in instructional technology; Manpower planning in fisheries – administration - teaching – research and extension activities. Research studies in fisheries training.

Practical

Simulated exercises on Commodity System Assessment Methodology, Planning a Workshops, Documenting Good Management Practices, Designing materials for Distance Learning, and using icebreakers, climate setting and team building exercises. Preparing script for Radio, Press and TV. Computer graphics, practicing folk methods. Taking photos for popular and scientific publications. Practicing the use of different projectors –systems of multimedia projection. Visit to inland fish farm, marine villages and industrial units and identification of technological problems in selecting extension methods and programmes.

6. FEX : 606 SOCIAL AND GENDER ISSUES IN FISHERIES (1+1)

Theory

UNIT I

Social life of fishers: Family, religion and caste among others; Economic, political and cultural organisation of fishers; demographic aspects; Social stratification, poverty and economic equality among fishers; social mobility and migration; social and economic relationship between fishers and nonfishers, Capacity development and social capital.

UNIT II

Rural development in India - concept and history; role of fisheries in rural development; Leadership and leaders in fisheries – types, their roles and function; identification, training and development of local leaders; Role of change agents; Indicators of social change and their measurement; Review of significant research findings.

UNIT III

Social change and social conflict in fisheries: concept and theories of social change; modernisation and social change in fisheries; impact of urbanisation; impact of trade liberalisation and globalisation; forms and content of social conflict in fisheries; conflict between traditional/small scale and modern mechanised fishers; conflict over inland and coastal aquatic resources; role of the State and international community in aquatic resources management and conflict resolution; extension and development programmes for fishers; role and functions of FFDA, BFDA and fisheries research institutes/colleges.

UNIT IV

Gender issues in fisheries: concept of gender; feminist movements, theories of gender inequality, empowerment discourse; division of labour between men and women; relationship between social class and gender; gender differences in socialisation, educational attainment and social mobility. Women and men in small scale fisheries and processing sector, Ergonomics and health issues; fishers and coastal resources management; technological changes and their implications for fishers; fishery cooperatives and empowerment; development programmes for fishers; globalisation and women fishers; policy issues.

Practical

Case studies on social and gender issues in fisheries; Case studies on social conflicts and their resolution; Tools and frameworks for gender awareness planning; Book review; Exercises in social and gender sensitive policies; Use of different methods of identifying village leaders – observation sociometry, key informant technique, etc.; Indexing leaders by leadership index; Identifying the indicators of social change and their measurement; Analysing the change agents role; Studying the consequences of social change.

7. FEX : 607 INFORMATION AND COMMUNICATION TECHNOLOGY FOR FISHERIES DEVELOPMENT (1+1)

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Theory

UNIT I

Concept of information communication technology and its role in fisheries development. Information communication technologies –print and electronic media, email, Internet, video and teleconferencing, computer assisted instructions, touch screens, micro computers and web technologies. Information kiosks. Networking system of information- type of network-PAN, LAN, Can, MAN, WAN, AGRINEt, e-Governance. Cyber extension. Extension through virtual mode, e-learning. Agricultural technology Information Centres (ATIC), technology parks. Management Information System in fisheries extension. Use of expert system in fisheries extension.

UNIT II

Internet in fisheries extension with specific reference to communication technology Internet – email – voicemail – teletext – videotext – tele and video conferencing and its application.

Practical

Study of different kinds of information technologies. Print and electronic media. Practicing tele and video conferencing. Development of computer assisted instructions. Touch screens and information kiosks. Study of computer networks and its applications in fisheries. Development and use of e-learning modules in fisheries. Audio aids – wireless public address system; multimedia Projectors; Audio recording – video recording –Audio cassette – Compact Disc (CD) production in fisheries; Various types of cameras – video format – digital cameras ; Video - video editing system - use of computer for video editing - non-linier editing; Power point software – designing slides – using templates. Digital photography – techniques application in extension; Study of various public address systems, Systems of Multimedia Projection, Practice and creation of interactive CDs in fisheries, Study and practice of various kinds of video editing systems. Practice and use of digital photography.

8. FEX : 608 INTERNATIONAL EXPERIENCES IN FISHERIES EXTENSION(2+0)

Theory

UNIT I

Understanding fisheries and aquaculture extension and development systems in South Asian countries and South East Asian countries - Thailand, Indonesia, Malaysia, Vietnam, Myanmar, China; Extension system in Japan; Linkages between Research and Development system in these countries; Status of fishing communities in these countries.

UNIT II

Analysing mission, approaches and achievements of fisheries development organizations: World Fish Centre, International Collective in Support of Fish Workers (ICSF), International Fishmeal and Oil Manufacturers Association (IFOMA), Asian Fisheries Society (AFS), National Marine Fisheries Service of USA, Fisheries Division of FAO, World Fish Forum, Asia-Pacific Fisheries Commission (APFIC), Committee for Inland Fisheries and Aquaculture of Africa (CIFAA) Commission for Inland Fisheries of Latin America (COPESCAL), European Inland Fisheries Advisory Commission (EIFAC), General Fisheries Commission for the Mediterranean (GFCM), Indian Ocean Tuna Commission (IOTC), Regional Commission for Fisheries (RECOFI), Western Central Atlantic Fishery Commission (WECAFC);

9. FEX : 609 ERGONOMICS (1+1)

Theory

UNIT I

Introduction to ergonomics and its multidisciplinary approach.

UNIT II

Human machine - environment interface, work study, posture, ergonomics aspects of environment: illumination, sound, temperature, humidity, radiant heat, air velocity, body dimensions, anthropometry and workplace design, fatigue, occupational health studies.

UNIT III

Application of ergonomics in fisheries and agriculture sector.

Practical

Physical environment study, assessment of body composition and dimensions, measurement of grip strength, measurement of physiological work by heart rate method and RPE, posture analysis by flexi curve, psycho- physiological tests; designing of ergonomics tool/product/system for fisheries sector; review paper on ergonomics and fisheries/agriculture.

Supporting Courses

1. FST 601. Advanced Statistical Methods 3(2+1)

Theory

UNIT I
Introduction to matrix algebra, Bayes' theorem and its application, mathematical expectation.

UNIT II
Probability distribution: Negative, Binomial, Hyper-geometric and Exponential and their application in fisheries; Multivariate normal distribution; Multiple and Partial correlation and regression.

UNIT III
Multivariate ANOVA; Likelihood Methods; Concept of Principal component analysis; Canonical correlation and Path coefficients; Discriminant analysis; Factor analysis and Cluster analysis; Transformations; Analysis of Covariance.

UNIT IV
Linear programming: Objective function, graphical solution of linear programming problem, Simplex method.

UNIT V
Non parametric test: Wilcoxon test, Mann-Whitney U-test, Kruskal and Wallis test and Friedman's test; Use of computer software for data analysis; Survival analysis.

Practical
Exercises on Bayes' theorem; Negative, Binomial distribution; Hypergeometric distributions; Exponential distribution; Multiple and partial correlation and regression analysis; Principal component analysis; Canonical correlation and path coefficients; Discriminant analysis; Factor analysis and Cluster analysis; Transformations; Covariance analysis; Wilcoxon test, Mann-Whitney test, Kruskal and Wallis test and Friedman's test and linear programming; Use of computer software.

2. FST 602 Software for Fisheries Data Analysis and management 2(0+2)

Practical
Introduction to computer software: SPSS, SAS, SYSTAT and STATISTICA for analysis and presentation of fisheries data; Basic concepts of database management systems; Introduction to MS-ACCESS, ORACLE (RDBMS); Exercises on analysis of data using MS-EXCEL, SPSS, SAS, FISAT, SYSTAT and STATISTICA; Creation of Database using MS-ACCESS, ORACLE.