

Course descriptions for doctoral programs

1-Aquaculture :

Course code	Course Title	Course Description
111301	<i>Endocrinology</i>	Endocrine system (structure and function of pineal, thyroid, ovary, testes and pituitary gland) in finfish. Hormonal control of oogenesis, spermatogenesis, final oocyte maturation, spermiation, spawning, fecundity and spawning recovery. Environmental factors influencing gonadal maturation. Reproductive cycle of finfish and shellfish. Neurosecretory system and neuroendocrine regulation of reproduction in finfish and shellfish. Role of pheromones in reproduction.
111302	<i>Nutrition and Energy</i>	Definition, energetics, expression of energy value of feed (gross energy, digestible energy, metabolizable energy, net energy), partitioning of energy and energy budget, protein energy ratio.
111303	<i>Molecular biology</i>	Nucleic acid structure, Genome organization, RNA techniques (hybridization, reporters), (qPCR) DNA sequencing methods (Sanger), DNA sequencing methods (whole genome approach), Gene mapping, map based cloning , Human genome variation, the concept of “race”, DNA damage, DNA repair, Technique: EMSA, Recombination, Transposons, Eukaryotic transcriptional regulation, Epigenetics, RNAi, Splicing, Agrobacterium and gene transformation.
111304	<i>Computer and its Application in Fisheries</i>	Basic components of Computer. Central Processing Unit (CPU), Computer terminals. Types of Software, Monitor program and Operating System, Utility and application program, High level languages. Application of Computer: Problems solving and flow chart. Word Processors-basic operation and its application .MS Power Point. Steps of Power Point Presentation. Slide preparation .Basic concepts of E –MAIL and Internet. Concepts of various Statistical packages and their application in fisheries data analysis.
111305	<i>Nanotechnology Applications in Aquaculture</i>	Man-made nanomaterials (NMs), nanopolymers and coatings to strengthen food packaging, antibacterial nanocoatings, transparent polymer films, Nanosensors on food packaging to report the deterioration of the fish or shellfish, food containing NMs and nanotechnology to improve the delivery of micronutrients or unstable ingredients in aquafeeds. nanoencapsulation technology for fat-soluble vitamins, minerals and fatty acids, antibacterial surfaces in the aquaculture system, nanodelivery of veterinary

		products in fish food using porous nanostructures, nanosensors for detecting pathogens in the water, nanotechnology in water purification for removing microbes, organic chemicals and metals, building materials, textiles and fabrics that could be used in aquaculture engineering, risks to the environment, Measurement methods for the environmental monitoring of NMs and the surveillance of NMs in products.
111306	<i>Marine Larviculture</i>	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. Culture of live feed for larval rearing, Development of inert feeds for larvae, Development of vaccines for larvae, Ontogeny of digestive system in fish larvae, Replacement of <i>Artemia</i> by formulated larval diets .
111307	<i>Formulation of Aquatic Diets – advanced</i>	Role of nutrients: amino acids, fatty acids, proteins, lipids, carbohydrates, vitamins and minerals. Nutritional bioenergetics: Fish as an open thermodynamic system, Energy requirement of fishes, protein to energy ratio, digestible energy, nitrogen balance index, protein sparing effect, high energy feeds, isocaloric diets, Optimal foraging theory, Mathematical modeling of ingestion, Metabolic rate, Energy budgets, Energetic efficiency of fish production. Feed Resources: Nutritional value of feed ingredients and live feed, Contribution from natural food to nutrient requirements of fish, Feed additives (attractants, growth stimulants and probiotics and binders), and Feed resources assessment. Feed Manufacture: Feed formulation and processing, On-farm feed manufacture, Commercial feed manufacture, Feed storage. Feeding Practices: Supplementary feed–theory and practice, Complete diet -theory and practice, Feeding methods and scheduling, ration size, feed performance and economics.
111308	<i>Physiology of fish diseases</i>	The Biology of Teleost Mucosal Immunity, Host Defense Peptides in Fish: From the Peculiar to the Mainstream, Viral Immune Defenses in Fish, Vaccination Strategies to Prevent Streptococcal Infections in Cultured Fish, Behavioral Defenses against Parasites and Pathogens, Pharmacology of Surfactants in Skin Secretions of Marine Fish, Defense Strategies of Opisthobranch Slugs against Predatory Fish, Behavioural Defenses in Fish, Defense against Pathogens and Predators during the Evolution of Parental Care in Fishes, Chemically Mediated Antipredator Defenses in Ostariophysans, Alarm Responses as a Defense.

111309	<i>Physiology of aquaculture digestion</i>	Digestive Physiology: Alimentary canal, its anatomy and histology; digestive fluids and enzymes; feeding mechanism; digestion of lipid, protein carbohydrate and absorption; control of digestive function; digestive system of shell fish and process of digestion.
111310	<i>Invertebrates physiology-advanced</i>	Introduction, Importance of Invertebrates, Etymology, Taxonomic significance, Number of extant species, Characteristics, Morphology and symmetry, Nervous system, Respiratory system, Digestive system, Integumentary system, Reproduction, Social interaction, Phyla, Classification of invertebrates, Classification ,Significance of groups.
111311	<i>Water quality management – advanced</i>	Nitrogen and ammonia toxicity; sledge accumulation, aerobic and anaerobic degradation of organic matter; sulphur cycle in pond bottom; effect of organic and inorganic fertilizers on pond productivity; optimum ecological factors and water quality management in culture systems. Biotechnology for water quality management in aquaculture, probiotics and bioremediators, treatment of fish farm effluents and environmental management.
111312	<i>Crustacean diseases - advanced</i>	Basic principles of immune system in shellfishes. shellfish health management: Host-pathogen-environment relationship, Management of culture systems, Environmental stress. Bacterial diseases of shellfish such as Vibriosis; Necrotizing hepatopancreatitis, rickettsial diseases, mycobacteriosis. Nodavirus infection of fish and freshwater prawns, WSSV, YHV. Molecular detection and sequence analysis of shellfish viruses. Parasitic and mycotic diseases: General characteristics, Epizootiology, Diagnosis, Life cycle, Prevention and treatment. Non-infectious Diseases: Nutritional diseases, water, soil, environmental parameters and their effects on fish health. Disease in hatcheries and grow out systems.
111313	<i>Fish parasitology – advanced</i>	Parasite taxonomy and morphology: Protozoan and metazoan parasites of fish. Life cycle of fish parasites. Parasite pathology: Pathology, treatments and control of the disease caused by protozoan parasites: <i>Costia necatrix</i> , <i>Trypanosoma</i> , <i>Trypanoplasma</i> , <i>Ichthyophthirius</i> , Urceolariid ciliates, Microsporidians, Myxozoans. Pathology treatments and control of the disease caused by Metazoan parasites: Trematodes: <i>Dactylogyrus</i> , <i>Gyrodactylus</i> , <i>Diplozoan</i> , <i>Sanguinicola</i> , <i>Neascus cuticola</i> , Cestodes: <i>Diphyllbothrium latum</i> , <i>Caryophyllaeus</i> , <i>Ligula</i> ; Nematodes: <i>Capillaria</i> , <i>Camallanus</i> . Pathology treatments and control of disease caused by Acanthocephalan parasites, Crustacean parasites: <i>Lernea</i> , <i>Argulus</i> , <i>Ergasilus</i> , fish leeches.
111314	<i>Zoonotic diseases in aquaculture</i>	Emerging zoonotic diseases and water, the criteria for determining whether a disease is zoonotic and water related. Impacts of anthropogenic and environmental factors on the distribution of zoonoses. The control envelope and risk management.

		<p>Epidemiological studies and surveillance. Incidence of the major zoonotic diseases transmitted by water in different geographical regions. Categories of waterborne diseases organisms. Control of zoonotic waterborne pathogens in animal reservoirs.</p>
<p>111315</p>	<p><i>Aquaculture Economics and Marketing</i></p>	<p>Nature and scope of natural resource economics, bio-economic analysis of fisheries. Growth, development and natural resource interrelationships. Pricing and optimal resource use over time under different market situations - role of market structure, interest rate, property rights in fisheries exploitation. Concept of externality - positive and negative externalities. Physical, legal and economic incentives to internalise the externalities. Fishery resource management policies - markets, taxes, subsidies, permits, direct controls, distributional effects of fisheries development. Nature and scope of aquaculture economics, production principles; Factor-Product, cost principles, Factor-factor. Product-product and law of comparative advantage, law of equimarginal returns, returns to scale and farm size, Homogeneous production functions; Cobb-Douglas and quadratic production functions. Risks and uncertainty; strategies for meeting risks and uncertainty. Economics of intensive, semi-intensive aquaculture. Role of marketing in fisheries and aquaculture, markets over space, intramarket price relationships. Market-structure conduct and performance. Developing marketing mix, product, pricing, place and promotion. Fisheries marketing organizations</p>

2-Aquatic products Processing & Preservation:

<i>Course code</i>	<i>Course Title</i>	<i>Course Description</i>
112301	<i>Safety evaluation of fisheries products</i>	The importance of food safety, Food safety management procedures, The principal causes of food borne illness, The principal symptoms of food borne illness, How food borne illness affects consumers and retailers, How poor safety practices affect food products, Food safety procedures in retail stores, Preventing food borne illness, Food hazards, The four c's, Record keeping, The principal food safety hazards on the human body, Basic rules regarding personal hygiene, Good Manufacturing Practice. Metal contaminants, Cleaner production in food industry-fruit and vegetable processing, seafood processing and contamination.
112302	<i>Nanotechnology applications in fish processing</i>	Food Packaging: A Major Goal Using Nanotechnology - Foodborne Diseases - Nanosensors for Foodborne Contamination - Using Food Packaging Sensors in Defense and Security - Other Kinds of Sensors: The Electronic Nose and The Electronic Tongue - Nano Bar Codes Detect Foodborne Diseases - Agriculture and Nanotechnology - Biosensor Detects Herbicides on the Farm - A Food Safety Issue - Atomic Force Microscopy and Food Research - Sustainable Watering of Crops - Fish Diseases - Biochips for Disease Detection in Livestock - Nanosensors to Track - Nanotechnology in Aquaculture and Fish Farming .
112303	<i>Foodborne toxins and contaminants</i>	Quantitative toxicology, Biotransformation, Mechanisms of toxicity, Heavy metals, Organic toxicants, Mycotoxins, Phycotoxins, Food additives, Nutrients, Other foodborne toxicants, food defense & chemicals of interest, HACCP planning & regulation of foodborne toxicants, General and acute toxicity – Mutagenicity and carcinogenicity.
112304	<i>Marine nutraceuticals and functional foods</i>	Marine Fisheries By-Products as Potential Nutraceuticals, Omega-3 Oils: Sources, Applications, and Health Effects, Microencapsulation of Marine Lipids as a Vehicle for Functional Food Delivery, Production of Bioactive Chitosan Oligosaccharides and Their Potential Use as Nutraceuticals, Glucosamine Production and Health Benefits, Functional and Bioactive Peptides from Hydrolyzed Aquatic Food Proteins, Marine-Derived Protein Hydrolysates, Their Biological Activities and Potential as Functional Foods, Seaweed Carotenoids, Marine Algae and Polysaccharides with Therapeutic Applications, Nutraceuticals and Functional Foods from Marine Microbes, Immunoenhancing Preparations of Marine Origin.

<p>112305</p>	<p><i>Biotechnology in fish processing</i></p>	<p>Feed biotechnology: Probiotics, single cell proteins, Nutraceuticals, Recombinant proteins of commercial importance: enzymes, hormones, bioactive compounds, therapeutic proteins., Rapid methods and automation for seafood microbiology, Microbiological control for fish smoking operations, New packaging technology for seafood preservation - shelf-life extension and pathogen control, Types of traditional fermented fish products, Proteases from aquatic organisms and their uses in the seafood industry, Bioprocessing of chitin and chitosan, Production of fish protein concentrates, Production of fish protein hydrolyzates by microorganisms, Lactic acid and propionic acid fermentations of fish hydrolyzates, Mussel processing wastes as a fermentation substrate,</p>
<p>112306</p>	<p><i>Fish handling & transportation-advanced</i></p>	<p>Structure of fish myosystems, Structural and chemical changes associated with postmortem, Fish as raw material for processing: Body structure, physical properties, shape, specific weight, bulk weight, angle of slip, weight composition, Factors affecting quality of fresh fish: intrinsic and extrinsic factors, Handling of fish onboard fishing vessels, Unit operations, unloading fish, Fish pumps, Post-harvest Fishery Losses, Methods to reduce losses, Handling Fish in Landing Centres, Defects and Modifications needed , Chill storage of fish: Heat load calculation, storage methods, insulated boxes and insulation thickness, different types of ice, physical, chemical and sensory changes during chill storage, iced storage shelf life, cold shock, physical, chemical and sensory methods of analysis, Different types of ice and their manufacture , Flow ice, Melanosis and its prevention, Discolouration in aquatic products, Depuration of bivalves, Modified atmosphere packaging. Transportation: Live fish/shell fish, Transportation of raw fish to local markets and processing centres, Improvements needed in transportation, Refrigerated transport systems, Classification of transport vehicles, Storage for transport, Cold chain, Packing systems.</p>
<p>112307</p>	<p><i>Consumer preferences and advertising technology</i></p>	<p>Consumers and seafood, Consumer attitudes toward seafood consumption, Improved eating quality of seafood: the link between sensory characteristics, consumer liking and attitudes, Evaluating consumer information needs in the purchase of seafood products, Consumer evaluation of tailor-made seafood products, health benefits of seafood, Protective effects of fish consumption in relation to gastrointestinal health, Fish consumption and the health of children and young adults, Histamine and biogenic amines: formation and importance in seafood, Seafood from source to consumer products, Developing functional seafood products, Improving</p>

		traceability in seafood production, Validation of traceability in the seafood production chain
112308	<i>Fisheries wastes processing technology</i>	Fish meal: Production - dry and wet process, machinery, control of quality of products, specifications, packaging and storage. Fish body and liver oils: Extraction, purification, preservation and storage, industrial and nutritional applications of fish oils. Vitamin A & D. Shrimp waste, crab shell and squilla utilization: Resources and composition, conventional uses, feeds and manure, conversion to useful materials like chitin, chitosan, glucosamine hydrochloride, shrimp extract, commercial production, production and use of protein isolates from squilla and shrimp waste. Fish silage: Acid silage and fermented silage, advantages over fish meal, nutritional value of silage. Fish hydrolysates: Production and utilization, biochemical composition and importance in food and nutrition. Miscellaneous by-products: Fish maws and isinglass, pearl essence, fertilizer, beche-de-mer, processing of snailmeat and jelly fish.
112309	<i>Bacterial and fungal toxicology</i>	Food-borne bacterial infections.. Food infections by <i>Salmonella</i> , <i>Clostridium perfringens</i> , <i>Vibrio parahaemoliticus</i> , Enteropathogenic <i>E. coli</i> , <i>Aeromonas hydrophila</i> etc., the nature of causative agent, its source, incidence, foods involved, the diseases, conditions for outbreak and prevention. The etiology of diseases: Conditions for outbreak & prevention. Botulism and staphylococcal food poisoning, organism responsible and their origin, growth and toxin production, nature of toxins, incidence of poisoning, foods involved. Food borne non-bacterial infections and intoxications: Aflatoxins, patulin, ochratoxin and other fungal toxins found in food, toxin producer, source, nature of toxin, toxicity and significance in foods. Virus and some parasites found in foods.
112310	<i>Fish cooling and freezing systems</i>	Freezing: Structure of water and ice, Influence of solutes on the structure of water and ice, phase equilibrium and freezing curves of pure water and binary solution, freezing curves for fish, determination of freezing points from time-temperature plots, calculation of freezing time, crystallization, nucleation, homogeneous and heterogeneous nucleation, super cooling, crystal growth, eutectic point, location of ice crystals in tissue, changes during freezing. Technological aspects of freezing: Methods of freezing, comparison of various freezing methods, selection of a freezing method, product processing and packaging, chemical treatment prior to freezing, antioxidants, cryoprotectants and other additives, Cryoprotectants: Mechanism of freezing injury and cryoprotection, various hypothesis glazing. Frozen storage:

		Physical changes – freezer burn and recrystallisation, different types of recrystallisation. Chemical changes - lipids, proteins, nucleotides, freeze denaturation and theories on denaturation, changes in pH. Bacterial changes. Sensory changes- texture, taste, odour, effect of post-mortem condition on sensory qualities, Water holding capacity, Time temperature tolerance, temperature and duration of storage on quality and shelf life. Arrangements within a cold storage, handling and stacking systems, space requirement filleting of fish, Treatments, Glazing, Packaging, Freezing, Processing of prawns, Lobster, Squid, Cuttle Fish, Crab, etc.
112311	<i>Biotechnology applications in fish nutrition</i>	Relevance of molecular studies in nutrition; terminologies in molecular nutrition; cell culture; nutritionally important genes; gene regulation by lipids and carbohydrates; metabolic control analysis; methodologies in molecular nutrition; Nutraceuticals: Definition, classification and role of different nutraceuticals; mode of application; functions of acidifiers (citric acid, propionic acid, benzoic acid); Exogenous enzymes (phytase, carbohydrase, proteinase) and nutrient utilisation; prebiotics and probiotics; Single cell proteins as nutraceuticals; antioxidants and their functions; Chemoattractants for fish and shellfish; fish based nutraceuticals and their application; designer fish; Immunostimulants and their functions (nucleotide, manan oligosaccharides, beta glucan, levan, bovine lactoferine, sodium alginate, levamisol).
112312	<i>Computer and its Application in Fisheries</i>	Basic components of Computer. Central Processing Unit (CPU), Computer terminals. Types of Software, Monitor program and Operating System, Utility and application program, High level languages. Application of Computer: Problems solving and flow chart. Word Processors-basic operation and its application .MS Power Point. Steps of Power Point Presentation. Slide preparation .Basic concepts of E –MAIL and Internet. Concepts of various Statistical packages and their application in fisheries data analysis.
112313	<i>Fishing technology</i>	Classification of fish catching methods, basic principles of fish catching; Factors determining the selection of gear; Fishing gears, Natural and synthetic materials in fishing gear; Choice of netting materials for different gears; Numbering of yarn; Construction and types of twines and ropes; Different types of floats, sinkers, anchors and buoys; Fabrication of fishing gears; Drawing and reading the gear designs; Description and operation of fishing gears - trawls, purse seines, gill nets and lines; Treatment and preservation of fishing gear. Fishing technology and resource management.

3-Aquaculture Biotechnology

<i>Course code</i>	<i>Course Title</i>	<i>Course Description</i>
112305	<i>Genetic improvement of fish</i>	Transgenic Technology and Fish Growth; Gene Transfer Technology for Genetic Improvement of Fish; Principle of Gene Transfer, Microinjection, Electroporation, Sperm mediated Gene Transfer; Application of Gene Transfer Technology for Genetic Improvement of Fish, Lipofection, Retroviral Infection; Generation and Identification of Transgenic Fish, Transgene Constructs, Gene Transfer, Screening of Putative Transgenic Fish, Expression and Inheritance of the Transgene in Transgenic Fish.
112306	<i>Molecular biology and bioinformatics</i>	DNA as genetic material, Chemistry of nucleic acids, Genetic code. Organization of genome in prokaryotes and eukaryotes. Concept of replication, transcription and translation. Recombinant DNA technology, Gene cloning and Transgenesis, Molecular and immunological techniques, Cell culture and cell lines, Development of vaccines, Hybridoma technology, Monoclonal antibody production, PCR techniques, Marine biotechnology – bioactive compounds from marine organisms, Waste water treatment, Biofilters in aquaculture, Biofertilizers, Probiotics, Biosensors, Bioprocessing. Concept of Bioinformatics - NCBI, Genebank sequence database-primary and secondary database.
112307	<i>Molecular biotechnology</i>	Molecular Tools used in Genetic Engineering: Restriction Endonuclease and Restriction mapping - DNA modifying enzymes:- Nuclease, Polymerase, Enzymes that modify the ends of DNA molecules, DNA ligase- joining DNA Molecules, Adaptors, Linkers, Homopolymer tailing, Cloning Strategies: Genomic libraries, Preparation of DNA fragments for cloning , Positional cloning, chromosome walking, Jumping., C-DNA Synthesis & cloning Genetic selection of screening methods:- Use of chromatographic substrate, Insertional inactivation, Complementation of defined mutation Methods based on nucleic acid homology (Southern, Northern, Western Blotting, Subtractive, colony & plaque hybridization, chromosomal walk In-situ chromosomal hybridization Immunological screening for expressed genome Microarray Technique. Nucleic acid Synthesis & Sequencing, Chemical & automated method, Methods of gene regulation in Eukaryotes (Antisense, RNA, PNA & RNAi) , Polymerase Chain Reaction, DNA markers:- RFLP, micro-minisatellites, SNPs, RAP Ds,AFLP, Linkage analysis, genotyping , & DNA

		fingerprinting , Applications of genetic engineering.
112308	<i>Microbial biotechnology</i>	Historical developments in industrial microbiology; industrially important microbes and metabolic pathways; Various Microbial metabolites and their Overproduction; Isolation and selection of industrially important microorganisms; Preservation and maintenance of microbial cultures. Microbial substrates and Media formulation; Components of microbial fermentation process; Types of fermentation processes- Solid state, Static and submerged fermentations; Design of laboratory bioreactor; Types of Bioreactor: Stirred tank reactor, bubble column etc.; Downstream processing Production of Microbial Biomass -Baker's Yeast, Mushroom; Production of fermented foods; Alcoholic beverages-wine, beer, etc.; Production of Ethanol, Citric acid; Amino acids and vitamins; Microbial enzymes for food, detergent and pharma industry; Biopesticides and biofertilizers. Production of Antibiotics; penicillin and other antibiotics; Bioweapons and Bioshields; Pigments, Microbial transformation, Production of Insulin , Interleukin, growth hormones, etc using rDNA technology.
112314	<i>Genetic improvement of crustaceans</i>	Application of genetic parameter information in formulation of breeding plans; Stock improvement plans; Development of new strains/synthetic population; Crossbreeding and hybridization; Selection and mating designs for select traits: growth, disease resistance, color enhancement, fin characters,; Application of markers in selection programs, status and their relevance; Development of breeding plans for different population sizes and environments; Trends in fish breeding research. Domestication and inadvertent selection; Genotype X Environment interaction and its role in fish/shellfish breeding.
112315	<i>Algae biotechnology</i>	Algal Biotechnology: biotechnological approaches for production of important microalgae, raceway system of micro algae culture, vitamins, minerals and omega3 fatty acids from micro algae, enrichment of micro algae with micronutrients.
112316	<i>Aquaculture genetics and biotechnology</i>	Genetic Manipulation: Chromosome structure and its manipulation. Sex-reversal and Sex control. Role of steroid in sex reversal. Triploidy, polyploidy, Androgenesis and Gynogenesis and its application in fish culture. Hybridization techniques of fishes. Genetic resources of

		India and Conservation. Cryopreservation of fish gametes. Application of Biotechnology: Hormonal manipulation in advancing maturity and reproduction. Biotechnology in aquaculture product development. Bio-fertilization and bio-fermentation. Application of biotechnology in aquaculture and fisheries management. Recombinant protein of commercial importance. IPR issues related to environmental biotechnology. Fish Cell and Tissue Culture: General principles of cell and tissue culture. Culture of primary cell and secondary cell (sub culture). Fish cell culture and development of fish cell lines and their application. Stem cell culture. DNA markers and MHS.
112317	<i>Biotechnology applications in fish nutrition</i>	Relevance of molecular studies in nutrition; terminologies in molecular nutrition; cell culture; nutritionally important genes; gene regulation by lipids and carbohydrates; metabolic control analysis; methodologies in molecular nutrition; Nutraceuticals: Definition, classification and role of different nutraceuticals; mode of application; functions of acidifiers (citric acid, propionic acid, benzoic acid); Exogenous enzymes (phytase, carbohydrase, proteinase) and nutrient utilisation; prebiotics and probiotics; Single cell proteins as nutraceuticals; antioxidants and their functions; Chemoattractants for fish and shellfish; fish based neutraceuticals and their application; designer fish; Immunostimulants and their functions (nucleotide, manan oligosaccharides, beta glucan, levan, bovine lactoferine, sodium alginate, levamisol).
112318	<i>Computer and its Application in Fisheries</i>	Basic components of Computer. Central Processing Unit (CPU), Computer terminals. Types of Software, Monitor program and Operating System, Utility and application program, High level languages. Application of Computer: Problems solving and flow chart. Word Processors-basic operation and its application .MS Power Point. Steps of Power Point Presentation. Slide preparation .Basic concepts of E –MAIL and Internet. Concepts of various Statistical packages and their application in fisheries data analysis.
112319	<i>Techniques in Genetic Engineering</i>	Principles and practices of genetic engineering; recombinant DNA technology and gene cloning methods. Polymerase Chain Reaction (PCR), Sequencing and DNA fingerprinting. Recombinant vaccines and transgenic fish DNA amplification and genomic DNA library. Gene therapy.
112320	<i>Biological control of Fish pathogens</i>	Probiotic Bacteria as Biological Control Agents in Aquaculture , General Considerations, Fish Eggs and

		Larvae, Fish Juveniles and Adults, Microbially Matured Water., Interaction with Nutritional Effects, Mode of Action, Production of Inhibitory Compounds, Competition for Chemicals or Available Energy, Competition for Adhesion Sites, Enhancement of the Immune Response, Interaction with Phytoplankton, Improvement of Water Quality, Screening and Preselection of Putative Probiotics. Evaluation of Pathogenicity of Selected Strains, Mode of application of the putative probiotic, Mass Production, Economic Evaluation, and Evaluation of Compliance with legislation, Development of Monitoring Tools.
112321	<i>Bioeconomics</i>	Fundamentals of fisheries bioeconomics, The Schaefer logistic growth model, The basic bioeconomic model, Deriving revenue and cost functions, Open access utilization of a fishery, Age-structured bioeconomic model, The age-class bioeconomic model, The fisheries management process, The paradigm of modern fisheries management, The specification of harvest control rules, Economic analysis of fishery regulation, Bioeconomics of ecosystem interdependencies, Ecological and technological interdependencies, Dealing with risk and uncertainty.