Semester-wise Course Contents and Lecture Schedule of B.F.Sc. (V Dean)				
Sr. No.	***Course code***	***Credit***	***Topic no.***	***Title and Content***
1	**2**	**3**	**4**	**5**
	I Year			**I Semester**
1	**AQ. 111**	**1+1=2**		**PRINCIPLES OF AQUACULTURE**
			Lecture	***THEORY :***
			1	Basics of Aquaculture- Definition and Scope
			2	History of Aquaculture.
			3	Present global and national scenario of aquaculture
			4	Aquaculture verses Agriculture.
			5	Systems of Aquaculture - Pond culture, pen culture, cage culture, running water culture, zero water exchange system etc.
			6	Principles of organic aquaculture
			7	Extensive, semi-intensive, intensive and supra intensive aquaculture in different types of water bodies viz. Freshwater, brackishwater and inland saline ground water.
			8	Pre -stocking pond management.
			9	Stocking and post -stocking pond management.
				Carrying capacity of pond and factors influencing carrying capacity.
			10	Criteria for selection of candidate species for aquaculture.
			11	Major freshwater candidate species for aquaculture
			12	Major brackishwater and marine candidate species for aquaculture
			13	Monoculture, polyculture and integrated culture system
			15	Water and soil quality in relation to fish production.
			16	Physical, chemical and biological factors affecting productivity of ponds.
			Practical	***PRACTICAL:***
			1	Aquaculture production statistics- World & India
			2	Aquaculture resources of world and India
			3	Components of Aquaculture farms
			4	Estimation of carrying capacity
			5	Study of practices of pre-stocking pond management , Drying, ploughing, Liming, Fertilization, etc.
			6	Study of practices of pre-stocking pond management , Eradication of aquatic insects
			7	Study of practices of pre-stocking pond management, Eradication of
			8	Study of practices of stocking pond management, Transportation methods
			9	Study of practices of stocking pond management, Acclimatization methods
			10	Study of practices of post-stocking pond management Feed management
			11	Study of practices of post-stocking pond management Health management
			12	Growth studies in aquaculture system
			13	Study on waste accumulation in aquaculture system (NH_3,)
			14	Study on waste accumulation in aquaculture system (Organic matter)
			15	Study on waste accumulation in aquaculture system (CO_2)
			16	Analysis of manure
2	**AQ. 112**	**2+1=3**		**FUNDAMENTAL OF BIOCHEMISTRY**
			Lecture	***THEORY :***
			1	A brief introduction to developments in biochemistry
			2	Transformation biochemistry to molecular biology
			3	Cell structure
			4	Water and major molecules of life
			5	Cell structure, water and major molecules of life.

			6	Carbohydrate chemistry: Structure, classification, functions (mono, di and polysaccharides).
			7	Isomerism and mutarotation
			8	Metabolism of carbohydrates: glycolysis, gluconeogenesis,
			9	Metabolism of carbohydrates: glycogenolysis, glycogenesis, TCA cycle
			10	Central role of TCA cycle in metabolism.
			11	Protein chemistry: classifications and functions.
			12	Classification, structure, function and properties of amino acids.
			13	Essential and non-essential amino acids.
			14	Primary, secondary, tertiary and quaternary structure of proteins.
			15	Amphoteric properties of protein.
			16	Biuret reaction and xanthoproteic reaction.
			17	Digestion and absorption of proteins.
			18	Classification, structure, functions and properties of lipids.
			19	Essential fatty acids and phospholipids.
			20	Digestion and absorption of lipids.
			21	Lipid autooxidation.
			22	Significance of Omega-3 and Omega-6 fatty acids.
			23	Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity.
			24	Enzymes: Kinetics and regulation of enzyme activity.
			25	Steroid and peptide hormones- chemistry and function.
			26	Structure and functions of fat and water soluble vitamins.
			27	Vitamins – classification- functions.
			28	Minerals – classification – functions.
			29	Nucleic acids: Structure function and importance genetic code.
			30	Transcription and translation
			31	Protein synthesis
			32	Energy changes in chemical reactions, reversible and irreversible reactions in metabolism
			Practical	***PRACTICAL:***
			1	General rules of biochemistry laboratory
			2	Preparation of normal solution of acid and base, buffers and reagents.
			3	Qualitative determination of carbohydrates
			4	Qualitative determination of proteins
			5	Qualitative determination of lipids
			6	Determination of moisture content
			7	Estimation of ash and sand content
			8	Estimation of total nitrogen and crude protein of fish tissue
			9	Extraction total lipids in fish tissue
			10	Estimation of total lipids in fish tissue.
			11	FUNDAMENTAL OF BIOCHEMISTRY
			12	Determination of specific gravity of oil.
			13	Extraction and estimation of total lipids in fish tissue.
			14	Determination of saponification value, iodine value and free fatty acid value.
			15	Determination of iodine value
			16	Determination of free fatty acid value
3	**FRM. 111**	**2+1=3**		**TAXONOMY OF FINFISH**
			Lecture	***THEORY :***
			1	Principles of taxonomy .
			2	Nomenclature and types
			3	Classification and interrelationships and Criteria for generic and specific identification.
			4-5	Morphological, morphometric and meristic characteristics of taxonomic significance.
			6-14	Major taxa of inland and marine fishes up to family level.

			15-16	Introduction to modern taxonomic tools:Karyotaxonomy, DNA barcoding, protein analysis and DNA polymorphism.
			Practical	***PRACTICAL:***
			1-8	Collection and identification of commercially important inland and marine fishes
			9-24	Study of their external morphology and diagnostic features.
			25-26	Modern taxonomic tools - Protein analysis and electrophoretic studies
			27-28	Karyotaxonomy - chromosome preparation and identification
			29-30	DNA barcoding
			30	DNA polymorphism
			28 -32	Visit to fish landing centres to study commercially important fishes and catch composition.
4	**FRM. 112**	**2+1=3**		**TAXONOMY OF SHELLFISH**
			Lecture	***THEORY:***
			1-6	Study of external morphology and meristic characteristics of crustacea and mollusca.
			7-16	Classification of crustacea and mollusca up to the level of species with examples of commercially important species.
			Practical	***PRACTICAL:***
			1-4	Study of external morphology.
			4-13	Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats.
			14-16	Field visits for collection and study of commercially important shellfishes.
5	**AAHM.111**	**2+1=3**		**FUNDAMENTALS OF MICROBIOLOGY**
			Lecture	***THEORY :***
			1	History of Microbiology and Microbial world
			2	Microscopy- Principle and constructionof brightfield, dark field, phase contrast, stereo, SEM and TEM.
			3	Prokaryotes– Morphology and ultrastructure of bacterial cell.
			4	General features, types and importance of viruses
			5-6	General features, types and importance of cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae
			7	Eukaryotes – Diagnostic features and importance of fungi and protozoa.
			8-9	Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms,
			10	staining techniques – simple, differential, structural staining
			11-12	Bacterial metabolism
			13-14	Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance.
			15-16	Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure,
			17-18	Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation
			19	Plasmids- types and their importance.
			20	Mutation –types and significance.
			21	Microbial ecology**:** Introduction and types of interaction, extremophiles and their significance
			22	Aquatic Microbiology:Introduction and **s**cope of aquatic microbiology,
			23	aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses;
			24	Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment.

			25	Microbial biofilms. Role of microbes in the production and breakdown of organic matter
			26	Role of microbes in sedimentation and mineralization process
			27-28	Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles.
			29	Sewage microbiology,
			30	self purification in natural waters, sewage treatment, drinking water microbiology
			31	sanitary quality of water for aquaculture, bioremediators.
			32	Economic significance of aquatic microbes
			Practical	***PRACTICAL:***
		1	1	Handling of microscopes, Wet mount, smear and hanging drop preparations
			2	Micrometry-Determination of size of micro organisms (ocular, stage micrometers).
			3	Tools and techniques in sterilization methods:Filteration, dry heat, moist heat, chemical agents
			4	Cultivation technique: Media preparation, Isolation -pure culture,
			5	Observation of fungi, blue-green algae, and protozoans.
			6	Staining techniques for bacteria– simple, differential, structural
			7	Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests.
			8	Collection of water and sediment samples for microbiological analysis
			9-12	Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems
			13-14	Study of bacteria involved in nutrient cycles
			15	water testing for potability, enumeration of coliform
			16	Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method.
6	**AEM.111**	**1+1=2**		**METEOROLOGY, CLIMATOLOGY AND GEOGRAPHY**
			Lecture	***THEORY :***
			1	Nature of Atmosphere: weather and climate;
			2	Composition of atmosphere;'structure of atmosphere.
			3	Heat energy of atmosphere: process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of atmosphere
			4	Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature
			5	Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements.
			6	Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India.
			7	Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms
			8	Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients.

			9	Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze.
			10	Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning.
			11	Weather forecasting: forecasting process; forecasting from local indications;
			12	Role of satellite in weather forecasting; synoptic weather charts
			13	Effects of climate change on fisheries sector
			14	Introduction to Geography; shape, size and structure of the earth
			15	Concepts of latitude, longitude, and great circles
			16	Model globe, maps and different types of projections; cartography;
			Practical	***PRACTICAL:***
			1	***Meteorology:*** Graphic representation of structure of atmosphere; physical layering and compositional layering.
			2	Temperature instruments: simple thermometers; six's Max-Min Thermometer; thermograph.
			3	Isotherms: world mean temperatures-January to July. India mean temperatures - January to July.
			4	Humidity measurement: hygrometer; psychrometer; relative humidity; dew point.
			5-6	Condensation: observation and identification of various types of clouds.
			7	Precipitation: measurement of rainfall using rain gauge.
			8	Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets-
			9	Atmospheric pressure measurement: fortin's mercurial barometer; Aneroid barometer.
			10	Isobars; India mean pressure - Jan to July.
			11	Wind observation and measurement: wind vane; cup anemometer.
			12	Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation.
			13	***Geography:*** The Earth: diagrammatic representation of shape, size, structure,
			14	Zones, latitudes, longitudes and great circles.
			15	Typical landscape mapping; map reading.
			16	Geographical terms used in landscape-
7	**AEM.112**	**2+1=3**		**SOIL AND WATER CHEMISTRY**
			Lecture	***THEORY :***
			1	Analytical chemistry: principles, applications and types.
			2	Classical methods of analytical chemistry, volumetry and gravimetry.
			3	Solutions: Standard solutions, titration, indicators, dilute solutions,
			4	Units of concentration: standard curve; nomogram.
			5	Chemistry of water: the water molecule, properties of pure water, fresh water and sea water.
			6	Composition of waters**:** surface water, ground water and sea water.
			7	Dissolved gasses: Factors affecting natural waters.
			8-9	Acid, base, salts: Hydrogen ions, modern concept of pH and buffer.
			10	Water analysis: collection and preservation of water samples.
			11	Measurement of temperature. transparency, turbidity,
			12	Determination of pH, electrical conductivity, salinity, chlorinity,
			13	Total solids (TDS, TSS, TVS, TVDS),

			14	Dissolved oxygen, free carbon dioxide, total alkalinity,
			15	Total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus.
			16	Water quality criteria/ requirements for Aquaculture.
			17	Soil Chemistry: origin and nature of soils.
			18-19	Physical properties of soil; soil colour. texture, structure, pore size, bulk density, water holding capacity.
			20	Soil types and their distribution.
			21-22	Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility.
			23	Soil reaction: acidity, alkalinity, conductivity, redox - potential.
			24	Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation.
			25-27	Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation.
			28	Soil analysis: collection and preparation of soil samples.
			29	Determination of soil texture, water holding capacity, pH, conductivity, organiccarbon, nitrogen, phosphorus, lime requirement.
			30	Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum.
			31	Environmental ameliorative: chlorination, deodorizers, bacterial formulation.
			32	Soil quality criteria/ requirements for aquaculture.
			Practical	***PRACTICAL:***
			1	Principles of Titrimetry, Gravimetry,
			2	Principles of Potentiometry, Conductometry, Refractometry,
			3	Principles of Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system.
			4	Demonstration: demonstration of laboratory glass wares and equipment used in water and soil analysis.
			5	Water analysis: measurement of temperature, turbidity,
			6	Determination of pH and EC.
			7	Determination of salinity, Chlorinity,
			8	Determination of Total solids, Redox potential,
			9	Determination of DO,
			10	Determination of Free CO_2.
			11	Determination of total alkalinity, hardness.
			12	Determination of inorganic nitrogen, and phosphorus.
			13	Soil analysis: Determination of soil texture, soil pH,conductivity,
			14	Determination of soil available nitrogen,
			15	Determination of soil available phosphorus,
			16	Determination of organic carbon.
8	**FPT.111**	**1+0=1**		**FISH IN NUTRITION**
			Lecture	***THEORY :***
			1	Composition of fish with emphasis on nutritional value.
			2	Protein in fish muscle.
			3	Concept of Biological value
			4	Protein Efficiency ratio
			5	Net protein utilization
			6	Amino acids of fish and shellfish.
			7	Importance of essential amino acids.
			8	Fatty acid composition of fish lipids.
			9	Nutritional quality of fish lipids.
			10	Role of fish lipids in human nutrition.
			11	Non-protein nitrogen substances in fishes.
			12	Significance of water soluble fish vitamins in human nutrition.
			13	Significance of fat soluble fish vitamins in human nutrition.

			14	Minerals in fish: micro- and macro-elements, trace elements, significance in human nutrition
			15	Other functional bio-molecules in fish (peptides, collagen and squalene) with their significance in human nutrition .
			16	Effect of different kinds of cooking fish such curry, frying steaming, smoking and fermentation on nutrition value.
9	**FEES.111**	**2+1=3**		**STATISTICAL METHODS**
			Lecture	***THEORY :***
			1	Definition of Statistics, Concepts of population, Sample.
			2	Census and sample survey.
			3	Classification of data.
			4	Frequency and cumulative frequency table.
			5	Diagrammatic and graphical representation of data
			6	Bar diagrams, Pie-diagram
			7	Histogram, frequency polygon, frequency curve.
			8	Ogive curves.
			9	Important measures of central tendency - arithmetic mean, Relative merits and demerits of these measures.
			10	Important measures of central tendency - median and mode. Relative merits and demerits of these measures.
			11	Important measures of dispersion - Range, Mean Deviation, Relative merits and demerits of these measures.
			12	Important measures of dispersion - Variance and Standard Deviation. Relative merits and demerits of these measures.
			13	Coefficient of variation; Normal Curve
			14	Concepts of Skewness and kurtosis.
			15	Definitions of probability, mutually exclusive and independent events, conditional probability,
			16	Addition and multiplication theorems.
			17	Random variable, concepts of theoretical distribution; Binomial distributions and their use in fisheries.
			18	Concepts of theoretical distribution; Poisson distributions and their use in fisheries.
			19	Concepts of theoretical distribution; Normal distributions and their use in fisheries
			20	Basic concept of sampling distribution; standard error and central limit theorem.
			21	Introduction to statistical inference, general principles of testing of hypothesis
			22	Types of errors.
			23	Tests of significance based on Normal distributions.
			24	Tests of significance based on t distributions.
			25	Tests of significance based on Chi-square distributions.
			26	Bivariate data, scatter diagram.
			27	Simple linear correlation, measure and properties
			28	Linear regression, Equation and fitting
			29	Relation between correlation and regression
			30	Length weight relationship in fishes
			31	Applications of linear regression in fisheries.
			32	Methodology for estimation of marine fish landings in India and problems encountered.
			Practical	***PRACTICAL:***
			1	Construction of questionnaires and schedules.
			2	Diagrams
			3	Frequency graphs
			4	Calculation of arithmetic mean.
			5	Calculation of median.
			6	Calculation of mode.

			7	Calculation of range, mean deviation.
			8	Calculation of variance, standard deviation.
			9	Exercises on probability
			10	Exercises on Binomial and Poisson distributions,
			11	Area of normal curve, confidence interval for population mean
			12	Test of hypothesis based on normal distributions
			13	Test of hypothesis based on t distributions
			14	Test of hypothesis based on chi-square distributions
			15	Computation of Simple correlation and regression
			16	Fitting of length - weight relationship in fishes.
10	**CNC.111**	**0+1=1**		**SWIMMING**
			Practical	***PRACTICAL:***
			1	History,
			2	Hazards in water and safety precautions;
			3	Pool maintenance and water quality control.
			4-5	Learning swimming, understanding and practice of ducking the head,
			6-8	Kicking action, holding breath under water
			9-11	Various strokes (free style, breast stroke, butterfly, back stroke);
			12	Competitive swimming-relays and medleys,
			13	Lap time practice, swimming and floating aids and their uses;
			14	Diving-styles of diving, rules, regulations and precautions. Methods of life savingin water;
			15	Boating, canoeing and sailing: types, maintenance,
			16	Skill development, rules and regulations and practice.
	I Year			**II Semester**
1	**AQ. 123**	**2+1=3**		**FRESH WATER AQUACULTURE**
			Lecture	***THEORY :***
			1	Major species cultured and Traits of important cultivable fresh water finfishes (Carps)
			2	Major species cultured and Traits of important cultivable finfishes and shellfishes.(Cat fishes)
			3	Major species cultured and Traits of important cultivable finfishes (Cold water fishes and fresh water shell fishes)
			4	Production trends and prospects of Freshwater Aquaculture in different parts of the world.
			5	Fresh water aquaculture resources - ponds, tanks, lakes, reservoirs, etc.
			6	Nursery pond management-control of aquatic weeds, insects and algal blooms, predatory and weed fishes, liming, fertilization/manuring, supplementary feeding
			7	Rearing pond management -control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, supplementary feeding
			8	Grow-out ponds management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding
			9	Water quality management
			10	Selection of fish seed
			11	Conditioning of fish seed
			12	Transportation of seed.
			13	Acclimatisation of seed.
			14	Culture methods of Indian major carps, Medium & minor carps and exotic carps -competition and compatibility
			15	Low-input, medium-input and high-input system of carp aquaculture
			16	Culture methods of cat fishes
			17	Culture methods of cold water fishes
			18	Culture methods of freshwater prawns

			19	Culture methods of mussels (Freshwater pearl culture)
			20	Culture methods of other freshwater exotic species
			21	Wintering ponds, quarantine ponds and isolation ponds
			22	Sewage-fed fish culture
			23	Principles of organic cycling and detritus food chain
			24	Use of agro-industrial waste and biofertilizer in aquaculture
			25	Exotic fish species introduced to India and its impact on indigenous fish fauna
			26	Periphyton based aquaculture system
			27	Species of fish suitable for integrated aquaculture.
			28	Integration of aquaculture with agriculture/horticulture- Paddy cum Fish/Shrimp Culture.
			29	Integration of aquaculture with agriculture/horticulture - sericulture cum fish culture
			30	Integration of aquaculture with agriculture/horticulture – Mushroom cum fish culture
			31	Integration of aquaculture with livestock- Cattle, poultry, Duck cum fish culture
			32	Cultivation of aquatic macrophytes with aquaculture (makahana).
			Practical	***PRACTICAL:***
			1	Preparation and management of nursery pond
			2	Preparation and management of rearing pond
			3	Preparation and management of grow out pond
			4	Study on effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes
			5	Collection, identification and control of aquatic weeds
			6	Collection, identification and control of aquatic insects
			7	Collection, identification and control predatory and weed fishes: eggs and larval forms of fishes
			8	Algal blooms and their control
			9	Estimation of plankton and benthic biomass.
			10	Study of natural and supplementary feeding in freshwater aquaculture
			11	Workout of economics of different culture practices- Carp culture
			12	Workout of economics of different culture practices- Catfish culture
			13	Workout of economics of different culture practices- Prawn culture
			14	Estimation of livestock requirement / Unit in integrated aquaculture
			15	Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment,
			16	Economics of different integrated farming systems
2	**AQ. 124**	**1+1=2**		**AQUACULTURE IN RESERVOIRS**
			Lecture	***THEORY :***
			1	Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity
			2	Classification of reservoir; factors influencing fish production; trophic phases in reservoir; pre-impoundment and post-impoundment stages and their significance in establishment of reservoirs fisheries.
			3	Salient features of reservoir limnology and their significance to fisheries development.
			4	Management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production.
			5	Fisheries of some important reservoirs; recent advances in reservoirs fisheries management.
			6	Conservation measures in reservoir fisheries.
			7	Fish stocking in Reservoirs
			8	Role of cage and pen culture in enhancement of fish production from reservoirs

			9	History of cage culture
			10	Advantages of cage culture; selection of suitable site of cage culture
			11	Cage materials, designs, shape, size and fabrication; cage frames and supporting system
			12	Integration of cage culture with other farming systems.
			13	History of pen culture. economics of cage and pen culture.
			14	Pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens
			15	Suitable species for culture in cages and pens
			16	Constraints in cage and pen culture.
			Practical	***PRACTICAL:***
			1	Preparation of charts on the present situation of reservoirs fisheries productivity: Small reservoirs
			2	Preparation of charts on the present situation of reservoirs fisheries productivity: Medium reservoirs
			3	Preparation of charts on the present situation of reservoirs fisheries productivity: large reservoirs
			4	Preliminary observations on hydrobiological parameters of the selected reservoir: Physical and chemical factors
			5	Preliminary observations on hydrobiological parameters of the selected reservoir: Biological factors
			6	Detailed case studies of selected reservoirs on the changing trends in capture fisheries profile: Small reservoirs
			7	Detailed case studies of selected reservoirs on the changing trends in capture fisheries profile: Medium reservoirs
			8	Detailed case studies of selected reservoirs on the changing trends in capture fisheries profile: large reservoir
			9	Drawing inferences from the analysis of data and suggestions for the sustainable development of reservoirs fisheries.
			10	Case studies on cage and pen culture: Site selection for cage and pen
			11	Case studies on cage and pen culture: Designing and layout of cage culture
			12	Case studies on cage and pen culture: Fabrication of cages and pens
			13	Case studies on cage and pen culture: Feeding rate, growth and health monitoring
			14	Case studies on cage and pen culture- Repair and maintenance of cages and pen
			15	Field visit to cage culture to acquaint with construction details and
			16	Field visit to pen culture site to acquaint with construction details and operation.
3	**FRM. 123**	**2+1=3**		**ANATOMY AND BIOLOGY OF FINFISH**
			Lecture	***THEORY :***
			1-2	Study of external and internal anatomy of important groups of finfish.
			3-4	Study of oral region and associated structures.
			5-7	Digestive system and associated digestive glands.
			8-9	Food and feeding habits of commercially important fishes.
			10-11	Qualitative and quantitative methods of analysis of gut contents.
			11-12	Circulatory system,
			13-14	Respiratory system,
			15-16	Nervous system,
			17-18	Urino-genital system
			19-20	Endocrine system
			21-23	Skeletal systems and sensory organs
			24-26	Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning.
			27-29	Eggs and larval stages and developmental biology.
			30	Age and growth determination by direct and indirect methods.

			31	Fish migration - type and significance.
			32	Tagging and marking.
			Practical	***PRACTICAL:***
			1-4	Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system.
			5-6	Study of food and feeding habits.
			7-8	Analysis of gut contents
			9-10	Estimation of age and growth by direct and indirect methods.
			11-12	Classification of maturity stages.
			13	Estimation of fecundity.
			14-15	Study of developmental stages.
			16	Tagging and marking.
4	**FRM. 124**	**2+1=3**		**INLAND FISHERIES**
			Lecture	***THEORY :***
			1-2	Freshwater fishery regions of the world and their major fish species composition.
			2	Global inland fish production data.
			3-4	Capture fishery resources of India.
			5-8	Potential of inland water bodies with reference to respective state.
			9	Problems in the estimation of inland fish catch data.
			10-13	Fishing crafts and gears.
			14-20	Major riverine and estuarine systems of India.
			21-24	Major brackish water lakes and their fisheries.
			25-28	Fisheries of major reservoirs / natural lakes of India.
			29-31	Flood-plain capture fishery- present status of their exploitation and future prospects.
			31-32	Cold water fisheries of India.
			Practical	***PRACTICAL:***
			1-6	Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups.
			7-10	Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters.
			11-12	Maintenance of records on catch data.
			13-16	Visit to Dept. of fisheries, lakes and reservoirs, net making yards.
5	**AEM. 123**	**2+1=3**		**LIMNOLOGY**
			Lecture	***THEORY :***
			1	Introduction to limnology: inland water types, their characteristics and distribution
			2	Ponds and lakes; streams and rivers; dynamics of lentic and lotic environments.
			3-4	Lakes their origin and their diversity: famous lakes of the world and India;
			5-8	Nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence ofphysical and chemical conditions on living organisms in inland waters
			9-13	Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity
			14-15	Aquatic plants: characterstics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role
			16	Nekton: distribution, movements.

			17	Benthos: classification; periphyton; zonation;
			18	Distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna
			19-23	Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment.
			24-27	Lotic environments: running waters in general; physical conditions;
			28-32	classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological
			Practical	***PRACTICAL :***
			1-5	Determination of physical characteristics of lentic and lotic water bodies
			6-9	Determination of chemical characteristics of lentic and lotic water bodies
			10-12	Collection and identification of fresh water phytoplankton Enumeration and biomass estimation of freshwater phytoplankton. Estimationof primary productivity in fresh water bodies Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton.
			13-14	Collection and identification of benthos from lakes and ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquaticplants from different fresh water bodies
			15-16	Field visit to lotic and lentic water bodies.
6	**AEM. 124**	**2+1=3**		**MARINE BIOLOGY**
			Lecture	***THEORY :***
			1-3	Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions.
######			4-6	Life in oceans - general account of major groups of phytoplankton and zooplankton groups.
			7-8	General account of sea weeds,
			9-10	Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide.
			11	Vertical migration of zooplankton,
			12	Phytoplankton-Zooplankton relationship,
			13-14	Geographical and seasonal variation in plankton production,
			15	Plankton and fisheries.
			16-19	Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation.
			20	Mud banks: formation, characteristics.
			21-23	Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries.
			24-25	Boring and fouling organisms.
			26-28	Nekton outline, composition of nekton, habitats of nekton.
			29-30	Bioluminescence and indicator species,
			31	Blooms,
			32	Red tides: cause and effects
			Practical	***PRACTICAL:***
			1-3	Study of common instruments used for collection of phytoplankton, zooplankton and benthos.
			4-6	Collection, preservation and analysis of phytoplankton,
			7-9	Collection, preservation and analysis of zooplankton,
			10-12	Collection, preservation and analysis of sea weeds,
			13-16	Collection preservation and analysis of inter tidal organisms.

7	**FPT. 122**	**2+1=3**		**FOOD CHEMISTRY**
			Lecture	***THEORY :***
			1	Composition of food and nutritional value.
			2	Moisture in foods.
			3	Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation.
			4	Naturally occurring polysaccharides in foods.
			5	Seaweed polysaccharides – sources and uses.
			6	Browning reactions – enzymatic and non-enzymatic.
			7	Metabolism of lipids and oxidation of fatty acids
			8	Lipoproteins; VLDL and HDL and their importance.
			9	Proteins: metabolism, deamination,decarboxylation and metabolic fate of amino acids .
			10	Nitrogen balance: positive nitrogen balance and negative nitrogen balance.
			11	Deamination reactions and nitrogen excretion with special reference to fish.
			12	Fish muscle proteins.
			13	Chemical changes in muscle during contraction.
			14	Proteins in foods
			15	Role in hydration- native and denatured proteins, gel formation,
			16	Functional properties of proteins,
			17	Changes Occure in protein during heat treatment and processing.
			18	Texturised proteins.
			19	Chemistry of taste, flavour and odour components in foods.
			20	Flavour intensifiers, synthetic flavouring substances.
			21	The taste of fish and shellfish.
			22	Food additives - types and their chemical nature.
			23	Emulsifiers and antimicrobial additives and sequestrants.
			24	Flavour potentiators, surface active agents; non-nutritive sweeteners, colour additives in food.
			25	Assessment of quality of food by instrumental methods.
			26	Assessment of quality of food by chemical methods.
			27	Nutritive value of foods.
			28	Energy value and energy requirements and their estimation.
			29	Water, electrolytic and acid-base balance.
			30	Nutritive value of proteins
			31	PER, BV digestibility coefficient, NPU values, pepsin digestibility.
			32	Role of fibre in human nutrition.
			Practical	***PRACTICAL :***
			1	Determination of moisture content in fish sample
			2	Estimation of crude protein of fish tissue
			3	Estimation of ash and sand content fish sample
			4	Estimation of fat content fish sample.
			5	Determination of energy value of fish
			6	Estimation of glucose content in food.
			7	Estimation of salt content in foods
			8	Colorimetric method of estimation of proteins.
			9	Colorimetric method of estimation of carbohydrates.
			10	Use of pH meter
			11	Estimation of freshness quality indices: TMA and TVBN.
			12	Determination of free fatty acids.
			14	Determination of peroxide value .
			15	Determination of TBA value of fish.
			16	Estimation of fibre in foods.
8	**FEES. 122**	**1+1=2**		**INFORMATION AND COMMUNICATION TECHNOLOGY**

			Lecture	***THEORY :***
			1	IT and its importance, IT tools, IT-enabled services and their impact on society.
			2	Computer fundamentals; hardware and software; input and output devices.
			3	Word and character representation;
			4	Features of machine language, assembly language, high-level language and their advantages and disadvantages.
			5	Principles of programming- algorithms and flowcharts.
			6	Operating systems (OS) - definition, basic concepts
			7	Introduction to WINDOWS and LINUX Operating Systems
			8	Local area network (LAN), Wide area network(WAN)
			9	Internet, World Wide Web
			10	HTML and IP
			11	Introduction to MS Office - Word
			12	MS -Excel, MS -Power Point.
			13	Audio visual aids - definition, advantages, classification and choice of A.V aids
			14	Cone of experience and criteria for selection and evaluation of A.V. aids; video conferencing.
			15	Communication process, Berlo's model
			16	Feedback and barriers to communication.
			Practical	***PRACTICAL:***
			1	Exercises on binary number system
			2	Algorithm and flow chart
			3-4	MS Word;
			5	MS Excel
			6	MS Power Point
			7	Internet applications
			8	Web browsing, Creation and operation of E-Mail account;
			9-10	Analysis of fisheries data using MS Excel.
			11	Handling of audio visual equipments.,
			12-13	Planning, preparation, presentation of posters, charts
			14	Overhead transparencies and slides.
			15-16	Organization of an audio visual programme
9	**CNC 122**	**0+1=1**		**PHYSICAL EDUCATION, FIRST AID & YOGA PRACTICES**
			Practical	***PRACTICAL:***
			1	Introduction to physical education: definition, objectives, scope, history, development and importance;
			2	Physical culture; Meaning and importance of Physical Fitness and Wellness;
			3	Physical fitness components - speed, strength, endurance, power, flexibility, agility, coordination and balance;
			4	Warming up - General & Specific & its Physiological basis;
			5	Test and measurement in physical education;
			6	Training and Coaching - Meaning & Concept;
			7	Methods of Training; aerobic and anaerobic exercises;
			8	Calisthenics, weight training, circuit training, interval training,
			9	Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems;
			10	Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process;
			11	Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning;

			12	Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.
			13	Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports;
			14	Governance of sport in India; Important national sporting events; Awards in Sports; History,
			15	Latest rules, measurements of playfield, specifications of equipments, skill, technique, style.
			16	Coaching of major games(Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics
	II Year			**III Semester**
1	**AQ. 215**	**1+1=2**		**ORNAMENTAL FISH PRODUCTION AND MANAGEMENT**
			Lecture	***THEORY :***
			1	World trade of ornamental fish and export potential.
			2	Different varieties of exotic fishes.
			3	Different varieties of indigenous fishes.
			4	Principles of a balanced aquarium.
			5	Fabrication, setting up and maintenance of freshwater and marine aquarium.
			6	Water quality management, Water filtration systems - biological, mechanical and chemical, Types of filters.
			7	Aquarium plants and their propagation methods.
			8	Lighting and aeration, aquarium accessories and decoratives.
			9	Aquarium fish feeds, Dry, Wet and live feeds.
			10	Broodstock management, Breeding and rearing of ornamental fishes: Live bearer
			11	Broodstock management, Breeding and rearing of ornamental fishes: Eggs layers
			12	Application of genetics and biotechnology for producing quality strains.
			13	Management practices of ornamental fish farms
			14	Common diseases and their control.
			15	Conditioning, packing, transport and quarantine methods.
			16	Trade regulations and Wild Life Act in relation to ornamental fishes.
			Practical	***PRACTICAL:***
			1	Identification of common ornamental fishes and plants.: indigenous species
			2	Identification of common ornamental fishes and plants.: Exotic species
			3	Identification of common ornamental fishes and plants.: Ornamental plants
			4	Identification of common ornamental fishes and plants.: Marine ornamental fishes
			5	Fabrication of all glass aquarium.
			6	Setting-up of aquarium tank
			7	Maintenance of an aquarium tank.
			8	Aquarium accessories and equipments.
			9	Conditioning and packing of ornamental fishes.
			10	Preparation of feed.
			11	Setting up of breeding tank for live bearers
			12	Setting up of breeding tank for barbs, gold fish and tetras etc.
			13	Setting up of breeding tank for Cichlids &Gouramies
			14	Setting up of breeding tank for fighters and cat fishes
			15	Identification of fish diseases and prophylactic measures.
			16	Assignment

2	**AQ. 216**	**1+1=2**		**FISH FOOD ORGANISMS**
			Lecture	***THEORY :***
			1	Introduction to Fish food organisms

			2	Candidates species of phytoplankton as live food organisms of freshwater and marine species.
			3	Candidates species of zooplankton as food organisms of freshwater and marine species
			4	Trophic potential - Proximate composition of live feed
			5	Biology, culture requirement, and methodology of culture of important live food organism: Green algae
			6	Biology, culture requirement, and methodology of culture of important live food organism: Blue-green algae (spirulina)
			7	Biology, culture requirement, and methodology of culture of important live food organism: Diatoms
			8	Biology, culture requirement, and methodology of culture of important live food organism: Infusoria
			9	Biology, culture requirement, and methodology of culture of important live food organism: rotifers
			10	Biology, culture requirement, and methodology of culture of important live food organism: Cladocerons
			11	Biology, culture requirement, and methodology of culture of important live food organism: Tubifex worm
			12	Biology, culture requirement, and methodology of culture of important live food organism: Brine shrimp
			13	Biology, culture requirement, and methodology of culture of important live food organism: Chironimids
			14	Biology, culture requirement, and methodology of culture of important live food organism: Earthworm
			15	Bait fish and forage fish: Types and candidate species
			16	Role of biofilm in aquaculture
			Practical	***PRACTICAL:***
			1	Introduction to culture of fish food organisms
			2	Qualitative and quantitative analysis of plankton - Collection and Preservation of Plankton
			3	Qualitative and quantitative analysis of plankton- Qualitative estimation
			4	Qualitative and quantitative analysis of plankton- Quantitative Estimation
			5	Identification Of Common Aquatic Flora And Fauna- Freshwater Fauna
			6	Identification of common aquatic flora and fauna : Brackishwater and marine flora and fauna
			7	Isolation and culture of microalgae: Important media used for algal culture:
			8	Isolation and culture of microalgae: Isolation of pure algal strains by agar plating
			9	Isolation and culture of microalgae: Mass culture of algae
			10	Culture of cladocerans: Stock culture
			11	Culture of cladocerans: Mass culture
			12	Culture of microworms
			13	Culture of infusoria
			14	Decasulation of artemia cyst
			15	Hatching of artemia cyst
			16	Evaluation of live food organism
3	**AQ. 217**	**1+1=2**		**GENETICS AND BREEDING**
			Lecture	***THEORY :***
			1	Principles of genetics and breeding.
			2	Gene and chromosome as a unit of inherritance, structure of genetic material.

			3	Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis.
			4	Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over. Introduction to population genetics.
			5	Hardy- Weinberg law and its significance.
			6	Chromosomal structure and aberrations. Chromosome manipulation techniques- androgenesis, gynogenesis and polyploidy and identification of ploidy.
			7	Sex determination
			8	Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes.
			9	Quantitative genetics – quantitative traits, polygenic traits, heritability.
			10	History and present status of selective breeding programs in aquaculture.
			11	Selection methods and mating designs. Design for selective breeding for Qualitative traits
			12	Selection methods and mating designs. Design for selective breeding for Quantitative traits
			13	Inbreeding and its consequences.
			14	Domestication methods.
			15	Seed certification and quarantine procedures.
			16	Cryopreservation of gametes.
			Practical	***PRACTICAL:***
			1-4	Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis.
			5-6	Problems on quantitative traits, response to selection and heritability.
			7	Estimation of rate of inbreeding.
			8	Estimation of heterosis.
			9	Mitotic and meiotic chromosome preparation.
			10-11	Demonstration of protocol of androgenesis, gynogenesis and polyploidy.
			12-13	Problems on gene and genotypic frequency.
			14	Gamete cryopreservation protocols
			15-16	Quality evaluation of fish milt.
4	**FRM. 215**	**2+1=3**		**PHYSIOLOGY OF FINFISH AND SHELLFISH**
			Lecture	***THEORY :***
			1-2	Water as a biological medium.
			3-5	Gas exchange;
			6-8	Circulation
			9-11	Excretion
			11-14	Osmoregulation
			15-17	Reproductive physiology
			18-19	Muscle physiology
			20-21	Sense organs
			22	Energy and nutrient status of food
			23-24	Nitrogen balance
			25	Standard and active metabolism
			26	Energy utilization

			27-28	Effect of environmental factors on physiology of fin and shellfishes
			29-30	Stress related physiological changes.
			31-32	Structure and functions of important endocrine glands.
			Practical	***PRACTICAL:***
			1-2	Estimation of oxygen consumption
			3-4	Osmoregulation
			5-6	Ammonia excretion and carbon-dioxide output
			7-9	Influence of temperature and salinity on metabolism
			10-12	Haematology of fin and shellfishes
			13-16	Histological techniques
5	**FRM. 216**	**1+0=1**		**AQUATIC MAMMALS, REPTILES AND AMPHIBIANS**
			Lecture	***THEORY :***
			1-7	Selected aquatic mammal, reptile, amphibian and birds species of India relevant to fisheries: taxonomic status, identification characters, distribution, abundance, habitat, exploitation, threats and conservation.
			8-14	Biology of aquatic animals: Cetaceans (whales. dolphins, porpoises and narwal), Sirenia (manates and dugongs), Carnivora (seals, sea lions walruses, polar bear and otter), Sea turtles, tortoise, crocodiles, sea/freshwater snakes and amphibians.
			15	Red list
			16	Wild Life (Protection) Act.
6	**AAHM. 212**	**1+1=2**		**FISH IMMUNOLOGY**
			Lecture	***THEORY :***
		2	1-2	Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system.
		1,2	3	Antigens – structure and types. epitopes, haptenes.
			4	Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins.
		5	5	MHC complex – types, structure, and functions.
			6	Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells.
			7	Antigen-antibody reaction - Precipitin reactions, agglutination reactions, Microorganisms associated with fishes in health and disease.
			8	Defense mechanism in finfish and shellfish- specific and non specific immune system.
		9	9	Pathogenicity and virulence. Sources of infection, transmission of disease producing organisms, portals of infection.
		10,11	10-11	Immunity to bacteria, fungi and parasites Role of stress and host defense mechanism in disease development.
		12	12	Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration.
		13	13	Serological methods in disease diagnosis.
		14	14	Immunostimulants –types, mechanism of action, modes of administration.
		15, 16	15-16	Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.
			Practical	***PRACTICAL:***
			1	Collection, separation and identification of fish leucocytes.
			2-3	Separation of blood plasma and serum.
			4-5	Differential counting - RBC and WBC by Haemocytometer.
			6-7	Study of different types of leukocytes and isolation of macrophages.
			8-9	Precipitin reactions - Agglutination test,

		10, 11(A Batch)	10-11	Precipitin reactions - immunogel diffusion,
			12	Precipitin reactions - double immuno diffusion,
			13-14	Precipitin reactions - radial immuno diffusion assay, ELISA.
			15-16	Methods of vaccine preparation and techniques of fish immunization.
7	**AEM. 215**	**2+1=3**		**AQUATIC ECOLOGY, BIODIVERSITY AND DISASTER MANAGEMENT**
			Lecture	***THEORY :***
			1	Aquatic environment, Flora and fauna: Components of aquatic systems,
			2-4	Aquatic productivity, nutrient cycles, energy flow, food chain.
			5	Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship.
			6-8	Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices.
			9	Ecological and evolutionary processes.
			10-12	Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes.
			13-14	Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries.
			15-16	Conservation programmes for endangered species, *ex situ* and *in situ* conservation, captive breeding and management of endangered species.
			17	Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.
			18	***Disaster Management in Fisheries:*** Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India.
			19	Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing,
			20	Introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters.
			21-22	Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures.
			23	During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices.
			24	Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation.
			25	Prevalent national and global management practices in disaster management.
			26	Agencies involved in monitoring and early warnings at district, state, national and global levels.
			27-28	Sea safety and health.
			29	Acquaintance with fire-fighting devices.
			30	Life saving appliances and first-aid.
			31	Uses of distress signals and technologies.
			32	Relief and rehabilitation measures, trauma counseling.
			Practical	***PRACTICAL:***
			1-2	Collection of species of fishes.
			3-5	Collection of species other organisms
			6-7	Studying the assemblages of organisms of rocky, sandy and muddy shores,
			8-9	Studying the assemblages of organisms of lentic and lotic habitats.

			10	Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation.
			11-13	Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs.
			14-16	Working out biodiversity indices.
8	**AEM. 216**	**1+1=2**		**FISHERY OCEANOGRAPHY**
			Lecture	***THEORY :***
			1	Introduction to Oceanography: classification; World's major oceans
			2	Expeditions national and international
			3	Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans
			4	Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves
			5	Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction
			6 - 10	Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino
			11	Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater.
			12	Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity
			13	General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans.
			14 -16	Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.
			Practical	***PRACTICAL :***
			1	Field visits & operation of oceanographic instruments- Nansen reversing water sampler, Reversing thermomete
			2-3	Bathythermograph,
			4	Grabs,
			5-6	Corers,
			7	Current meters,
			8	Tidal gauges,
			9	Echo-sounder.
			10	Bottom topography of ocean
			11-16	Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water
9	**FPT. 213**	**1+1=2**		**FREEZING TECHNOLOGY**
			Lecture	***THEORY :***
			1	Introduction to freezing technology
			2	Characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism.
			3	Handling of fresh fish;

			4	Sanitation in processing plants
			5	Principles of low temperature preservations. Chilling of fish - methods and equipment for chilling.
			6	Icing – quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage
			7	Use of antibiotics and chemicals.
			8	Freezing of fish fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate.
			9	Methods of freezing.
			10	Physico– chemical changes that occur during freezing and mechanism of ice crystal formation.
			11	Preparation of fish for freezing.
			12	Changes that occur during frozen storage – microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip
			13	Protective treatments – polyphosphate, glazing, antioxidants, packaging;
			14	Thawing of frozen fish – methods of thawing
			15	Transportation of frozen fish and cold chain.
			16	Quality control, HACCP in freezing industry.
			Practical	***PRACTICAL :***
			1	Sanitation and plant housekeeping.
			2	Chilling and freezing equipment.
			3	Packages and product styles.
			4	Methods of icing fish
			5	Calculation of cooling rate
			6	Preservation of by chilled sea water
			7	Drawing freezing curve of fish.
			8	Drawing thawing curve of fish.
			9	Freezing of whole fish
			10	Freezing of whole prawn
			11	Freezing of different varieties of fish and shellfish
			12	Estimation of driploss.
			14	Determination of quality changes during frozen storage.
			15	Inspection of frozen fishery products
			16	Visits to ice plants, cold storages and freezing plants
10	**FEES. 213**	**2+1=3**		**FISHERIES ECONOMICS**
			Lecture	***THEORY :***
			1	Introduction to fisheries economics.
			2	Basic economic terminologies - micro and macro-economics, positive and normative economics.
			3	Environmental economics, resource, scarcity, farm-firm relationships, production etc.
			4	Contribution of fisheries sector to the economic development of country
			5	Micro-economics: theories of demand, supply.
			6	Market - equilibrium price, consumption, utility, consumer's surplus.
			7	Elasticity -price, income, cross,
			8	Application of elasticity in fisheries managerial decision.
			9	Farm production economics - production functions in capture fisheries.
			10	Farm production economics - production functions in culture fisheries.
			11	Costs and returns.
			12	Breakeven analysis of fish production system.
			13	Concepts of externalities.
			14	Concepts of social cost.
			15	Factors of production, marginal cost and return.
			16	Law of diminishing marginal return, returns to scale.
			17	Economies of scale and scope.
			18	Revenue, profit maximization, measurement of technological change.

			19	Farm planning and budgeting. Significance or importance of marginal cost.
			20	Macro-economics: Introduction to national income, accounting.
			21	Measurement and determinants of national income.
			22	Contribution of fisheries to GNP.
			23	Contribution of fisheries to employment.
			24	Balance of payments.
			25	Economic growth and sustainable development.
			26	Globalisation: dimensions and driving Forces. Introduction to GATT and WTO.
			27	WTO Framework - Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations, Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures.
			28	Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO.
			29	Intellectual Property Rights (IPR) and different forms.
			30	Patents and patenting process, Agreement on TRIPS. Bio-piracy.
			31	GMOs in fisheries.
			32	Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.
			Practical	***PRACTICAL:***
			1	Demand functions of fish market - determination of equilibrium price for fish and fisheries products.
			2	Supply functions of fish market - determination of equilibrium price for fish and fisheries products.
			3	Calculation of price elasticities.
			4	Calculation of income elasticities.
			5	Calculation of cross elasticities.
			6-7	Production function - production with one or two variable inputs.
			8	Shifting demand and surplus curve and its important in fish price.
			9-10	Economic analysis on cost, return and break even of fish farm
			11-12	Economic analysis on cost, return and break even of shrimp farm
			13-14	Economic analysis on cost, return and break even of seed production unit
			15-16	Economic analysis on cost, return and break even of Export unit.
	II Year			**IV Semester**
1	**AQ. 228**	**2+1=3**		**COASTAL AQUACULTURE AND MARICULTURE**
			Lecture	***THEORY :***
			1	An over view of sea farming and shore based aquaculture in different parts of world: Global aquaculture production
			2	Resources for shore based aquaculture and sea farming in India.
			3	Traits of important cultivable fish and shellfish: Sea bass, mullet, milkfish, grouper, snappers, ayu, pearlspot , etc
			4	Traits of important cultivable fish and shellfish: Tiger shrimp, white shrimp, Vennamei shrimp, mud crab,
			5	Traits of important cultivable fish and shellfish: Mussel & clam species
			6	Traits of important cultivable fish and shellfish: Edible & pearl oyster species
			7	Traits of important cultivable fish and shellfish: seaweeds
			8	Seed resources of fin fish and shell fishes
			9	Traditional (bheries, Gheries) shore based aquaculture systems in India
			10	Traditional shore based aquaculture systems in India: Pokali fields in kerala
			11	Traditional (gaznis and khazans) shore based aquaculture systems in India

			12	Site selection for coastal aquaculture and mariculture
			13	Farm designing for coastal aquaculture
			14	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish.: Culture of Sea bass
			15	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish: Culture of Mullet
			16	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of Milk fish
			17	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of Grouper
			18	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of shrimp
			19	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of Mud crab
			20	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of clam
			21	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of mussel
			22	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of oyster
			23	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of pearl oyster
			24	Extensive, semi-Intensive, intensive aquaculture practices of commercially important species of fish and shellfish. Culture of sea weed
			25	Methods of aquaculture - cages
			26	Methods of aquaculture - Rafts, racks, poles and ropes
			27	Water and soil quality management: Important water quality parameters
			28	Water and soil quality management: Management including reclamation of acid sulphate soil
			29	Estimation of growth, survival and pond productivity
			30	Modern practices of shrimp farming in India
			31	Economic analysis of modern shrimp farming
			32	Sea ranching.
			Practical	***PRACTICAL:***
			1	Identification of important cultivable fishes: Fin fishes
			2	Identification of important cultivable fishes: Crustaceans
			3	Identification of important cultivable fishes: Mollucs
			4	Collection and identification of commercially important seed of fish .
			5	Collection and identification of commercially important seed of shellfishes
			6	Types of fertilizers- pond preparation.
			7	Seed selection and quality
			8	Techniques of acclimatization of fish seed
			9	Water quality parameters.
			10	Estimation of seed survival.

			11	Pond biomass estimation.
			12	Material, apparatus and machinery for shore based aquaculture and sea farming.
			13	Material, apparatus and machinery sea farming.
			14	Estimation of feed intake.
			15	Growth and health monitoring.
			16	Fouling organism in cages and pens.
2	**AQ. 229**	**2+1=3**		**FISH NUTRITION AND FEED TECHNOLOGY**
			Lecture	***THEORY :***
			1	Fundamentals of fish nutrition and growth in fish.
			2	Principal nutrients and nutritional requirements of cultivable fish and shellfi
			3	Principal nutrients and nutritional requirements of cultivable fish and shellfish (protein requirement)
			4	Principal nutrients and nutritional requirements of cultivable fish and shellfish (Fat/Lipid requirement)
			5	Principal nutrients and nutritional requirements of cultivable fish and shellfish (carbohydrate requirement)
			6	Principal nutrients and nutritional requirements of cultivable fish and shellfish (Vitamin requirement)
			7	Method of feed formulation (pearson square method) Feed formulation .
			8	Method of feed formulation (Best buy ingredient method)
			9	Method of feed formulation (Simultaneous equation and linear programming method)
			10	Feed manufacturing
			11	Forms of feed : wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets.
			12	Forms of feed : Spray dried diet, Micro-bound diet, micro encapsulated diet, flake diet)
			13	Feed additives : binders, antioxidants, Anti microbial agents enzymes, pigments, growth promoters, feed stimulants.
			14	Feed additives: Anabolic agents, enzymes, pigments, growth promoters, Chemo attractants and feed stimulants.
			15	Feed additives: Probiotics and immune-stimulants
			16	Feed storage: Role of moisture and heat
			17	Feed storage: Microbial, insect/rodent damage
			18	Feed storage: Chemical changes during storage and storage time of selected feed stuff
			19	Feed storage, use of preservatives and antioxidants.
			20	Feed evaluation - Feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value.
			21	Nutritional qualities of feed stuff: Chemical characteristics, digestibility studies
			22	Nutritional qualities of feed stuff: water stability and sinking rate, performance of cultured species, Field evaluation, etc
			23	Different types of feeding devices
			24	Method of feeding: Hand feeding, bag feeding, Automatic feeders
			25	Feeding frequency and feeding rate
			26	Different types of feed ingredients: Ingredients of animal origin
			27	Different types of feed ingredients: Ingredients of plant origin
			28	Anti nutritional factors in feed ingredients: Natural, contaminants, and artificial antagonist
			29	Feed digestion: Digestive fluid and enzymes,
			30	Protein, Fat, Carbohydrate and Microbial digestion
			31	Factors affecting digestibility and digestibility estimation
			32	Nutritional deficiency diseases

			Practical	***PRACTICAL:***
			1	Proximate composition: analysis of feed ingredients and feeds.(Protein Estimation- Digestion)
			2	Proximate composition: analysis of feed ingredients and feeds.(Protein Estimation- Extraction and estimation)
			3	Proximate composition: analysis of feed ingredients and feeds.(Fat Estimation)
			4	Proximate composition: analysis of feed ingredients and feeds.(Moisture Estimation)
			5	Proximate composition: analysis of feed ingredients and feeds.(Ash Estimation)
			6	Preparation of artificial feeds using locally available feed ingredients.(Feed formulation exercise)
			7	Preparation of artificial feeds using locally available feed ingredients.(Feed formulation exercise)
			8	Preparation of artificial feeds using locally available feed ingredients.(Weighing, Grinding, mixing, pelleting and drying)
			9	Calculation of feeding rate and feeding frequency
			10	Method of feeding
			11	Determination of sinking rate and stability of feeds.
			12	Determination of storage effect on feed quality -Protein associated changes
			13	Determination of storage effect on feed quality –Fat associated changes
			14-16	Students Project Work: Testing and evaluation of formulated fish feeds on fish growth and survival
3	**AQ. 221**	**1+1=2**		**SHELLFISH HATCHERY MANAGEMENT**
			Lecture	***THEORY :***
			1	Natural seed resources of shell fishes; site selection and collection methods
			2	Life cycle of important shellfishes: *Penaeusmonodon, Penaeusindicus* and *Macrobrachiumrosenbergii, Scylla serrata* and Lobster
			3	Life cycle of important shellfishes: Edible oyster and Pearl oyster, Holothurians
			4	Life cycle of important shellfishes: , horse shoe crab, *Sepia, Loligo,* Cray fish, etc.
			5	Sexual maturity and breeding seasons of different species: *Penaeusmonodon , Penaeusindicus, Macrobrachiumrosenbergii, Crab ,* Lobster, Oyster, Mussel etc
			6	Maturation stages of *Macrobrachiumrosenbergii and Penaeusmonodon*
			7	Induced maturation in *Penaeusmonodon* by eye-stalk ablation
			8	Reproductive hormones in crustaceans
			9	Broodstock management of *Macrobrachiumrosenbergii and Penaeusmonodon*
			10	Breeding and hatchery management of *Macrobrachiumrosenbergii*
			11	Breeding and hatchery management of *Penaeusmonodon*
			12	Breeding and hatchery management of crabs, lobster, mussel, oyster, etc
			13	Food and feeding of larval stages of *Macrobrachiumrosenbergii*
			14	Food and feeding of larval stages of *Penaeusmonodon*
			15	Food and feeding of larval stages of *Crab, Oyster, Mussel etc*
			16	Health management in hatcheries.
			Practical	***PRACTICAL:***
			1	Identification of brood stock and maturity stages of important crustaceans.
			2	Identification of brood stock and maturity stages of important molluscs
			3	Breeding and larval rearing of *Macrobrachiumrosenbergii*

			4	Breeding and larval rearing of *Macrobrachiumrosenbergii* and*Penaeusmonodon*
			5	Identification of larval stages of *Macrobrachiumrosenbergii*
			6	Identification of larval stages of *Penaeusmonodon*
			7	Identification of larval stages of mud Crab
			8	Identification of larval stages of Oyster
			9	Identification of larval stages of Mussel
			10	Demonstration of eyestalk ablation in *Penaeusmonodon* .
			11	Collection, packing and transportation of shrimp / prawn seed and brood stock.
			12	Practice in the operation of shrimp and prawn hatcheries.
			13	Observations on gonadal maturation of *Macrobrachiumrosenbergii* .
			14	Observations on gonadal maturation of *Penaeusmonodon* .
			15	Water treatment and management in shrimp and prawn hatcheries.
			16	Different chemicals and drugs used in shrimp / prawn hatcheries.
4	**AAHM. 223**	**2+1=3**		**FISH AND SHELLFISH PATHOLOGY**
			Lecture	***THEORY :***
			1 - 2	Significance of finfish and Shellfish diseases in aquaculture
			3 - 5	Host, Pathogen and Environment Interaction.
			6-7	Disease development process
			8-10	Stress in aquaculture and its role in disease development
			11-13	Pathological processes: Cellular response to injury, Inflammatory response to diseases.
			14-17	Pathogencity mechanism of parasite, bacteria, virus and fungus.
			18-22	Case history and clinical sign in disease diagnosis
			23- 27	Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals and metabolites, free radicals, oxidants) soil and water parameters in fish health
			28-30	Nutritional diseases fin fish and shellfish
			30 - 32	Non-infectious diseases fin fish and shellfish
			Practical	***PRACTICAL :***
			1-4	Live and post mortem examination of fish and shellfish
			5-8	Pathology of organ systems.
			9-12	Histopathology of normal and diseased fish and shellfish
			13-16	Diagnosis of abiotic fish diseases
5	**AAHM. 224**	**1+1=2**		**THERAPEUTICS IN AQUACULTURE**
			Lecture	***THEORY :***
			1	Scope and current scenario of therapeutics in aquaculture
			2	Chemotherapy: History, definition, terms used.
			3	Antibacterial agents, mode of action, general principles and classification
			4	Antibiotics; different classes and their mode of action, properties etc. Antibiotic resistance.
			5	Antiseptics and disinfectants.
			6	Antiparasiticides: Ectoparasites, Endoparasites and Protozoanes.
			7	Antibiotics used in aquaculture
			8	Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action.
			9	Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders and dosage.
			10-12	Therapeutics in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anesthetics, flesh color enhancers, Chemicals of therapeutic value, Law priority aquaculture drugs.
			13-15	Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices,
			16	List of the drugs used in aquaculture with therapeutics

			Practical	***PRACTICAL :***
			1- 2	Regulations of drug use in Aquaculture.
			3 - 5	Study of antimicrobials agents used in aquacultuer
			6	Preparation of potassium permanganate solution
			7	Preparation of weak Tincture Iodine
			8 -10	Five-plate screening test for the detection of antibiotic residue
			11- 13	Calculation of different disinfectants dosage in treating fish ponds
			14 - 16	Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.
6	**FPT. 224**	**1+1=2**		**FISH CANNING TECHNOLOGY**
			Lectures	***THEORY :***
			1	Introduction to canning and its historical developments.
			2	Advantages of canning in relation to other preservation methods.
			3	Raw materials and sub materials, their characteristics and suitability for canning.
			4	Classification of foods based on pH
			5	commercial sterility, Absolute sterility, pasteurisation and sterilization.
			6	Canning process, process flow steps involved HTST and aseptic canning.
			7-8	General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage.
			9	Principles of thermal processing. Heat resistance of micro organisms, heat penetration studies, mechanism of heat transfer
			10	Cold spot and its importance, convection and conduction type of packs.
			11	Estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate).
			12	Commercial sterilization, 12-D concept
			13	Canning of commercially important fin fishes, shell fishes and cephalopods.
			14	Spoilage of canned foods, types, causes and preventive measures
			15	Quality standards, plant layout, hygiene and sanitation and waste disposal.
			16	Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches
			Practical	***PRACTICALS:***
			1	Types of cans
			2	Canning equipments
			3	Layout of cannery
			4	Canning of different varieties of fish and shellfish
			5	Cutout test of canned product.
			6	Examination of can double seam.
			7	Heat resistance of bacteria
			8	Heat penetration in canned food
			9 -12	Thermal process calculation by general method
			13	Study of spoilage conditionincannedproducts
			14-16	Familiarization with various packaging materials andcontainerforfishproducts.
7	**FPT. 225**	**1+1=2**		**FISH PACKAGING TECHNOLOGY**
			Lecture	***THEORY :***
			1	Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements.
			2	Packaging materials, basic and laminates, principles of their manufacture and their identification
			3	Properties of packaging materials and their use in protective packaging with special reference to food.
			4	Printing for packaging and print identification.
			5	Closures of packaging, heat seals bottle closure.
			6	Principles of packaging fresh produce handling and transportation.
			7	Packaging for retail sale and storage.
			8	Packaging equipment and machinery.

			9	Package design, evaluation and testing
			10	Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials.
			11	Laminations and co-extrusions
			12	Retort pouch packaging - advantages and disadvantages. Biodegradable films, vacuum packaging, active packaging
			13	MAP, Polymeric Packaging.Packaging requirements of fresh fish, Frozen fish, Canned Fish
			14	Transport worthiness of packaging materials, accelerated shelf testing
			15	Materials and their safe use in food contact application.
			16	Safety and legislation aspects of packing. Labeling and bar coding.
			Practical	**PRACTICAL:**
			1	Determination of grammage of paper and board.
			2	Bursting strength, burst factor.
			3	Punctures resistance.
			4	Water proofness,
			5	Stiffness of the board, ring stiffness of paper and board
			6	Flat crush,
			7	Tensile strength and elongation at break of plastic films
			8	Density of plastic films
			9	Breaking length, impact strength of plastic films
			10	Tearing strength of paper and plastic films,
			11	Water vapour transmission rate
			12	Oxygen transmission rate
			13	Heat seal strength
			14	Suitability of plastic films for food contact applications
			15	Evaluation of retort pouch
			16	Identification of plastic films
8	**FE. 221**	**1+1=2**		**FISHING CRAFT TECHNOLOGY**
			Lecture	***THEORY :***
			1	Introduction: History & development of fishing crafts.
			2	Traditional Fishing crafts of India.
			3	Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation.
			4	History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel.
			5	Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules.
			6	State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB).
			7	Stability of fishing vessels- longitudinal and transverse.
			8	Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight,
			9	Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT).
			10	Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages.
			11	Deck fitting.
			12	Maintenance of fishing vessels.
			13	Fouling and boring organisms; seasoning and preservation of wood.
			14	Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat.
			15	Constructional details of Steel, FRP, Ferro Cement and Aluminum boats.

			16	Introduction of Outboard and inboard engines.
			Practical	**PRACTICAL:**
			1	Studies on traditional fishing crafts
			2	Introduction to drawing and drawing instruments
			3	Lettering, Geometrical construction, Curves.
			4	Projections
			5	Projection of points, planes
			6	Projection of solids
			7	Lines plan drawing
			8	Drawing of back bone assembly
			9	U & V bottom hull of wooden boat
			10	General view of boat
			11	Drawing of sheer plan,
			12	Body plan and
			13	Half breadth plan
			14	Types of marine engines
			15	Installation of marine engines
			16	Visit to boat building yard and dry dock.
9	**FEES. 224**	**1+1=2**		**FISHERIES EXTENSION EDUCATION**
			Lecture	***THEORY :***
			1	Introduction to extension education and fisheries extension- Concepts, objectives and principles
			2	Extension education, formal and informal education
			3	History and role of fisheries extension in fisheries development.
			4	Fisheries extension methods- individual, group and mass contact methods and their effectiveness
			5	Factors influencing selection and use of Fisheries extension methods
			6	Characteristics of technology, transfer of technology process, Important TOT programs in fisheries;
			7	Role of NGOs and SHGs in fisheries
			8	Fisheries co-management
			9	Adoption and diffusion of innovations, Adoption and diffusion process
			10	Adopter categories and barriers in diffusion of fisheries innovations
			11	Extension program planning and evaluation - steps and importance;.
			12	Participatory planning process
			13	Basic concepts in rural sociology and psychology and their relevance in fisheries extension
			14	Social change, social control, social problems and conflicts in fisheries
			15	Gender issues in fisheries
			16	Theories of learning, learning experience, learning situation
			Practical	**PRACTICAL:**
			1-2	Collection of socio-economic data from fishing villages;
			3	Study of social issues/problems through participatory and rapid rural appraisal techniques,
			4	Study of social issues/problems through stake holders analysis
			5	Study of social issues/problems through needs assessment
			6	Assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis;
			7-9	Case studies on social/gender issues and social conflicts in fisheries.
			10-11	Case studies on extension programs and Success stories.
			12-13	Practical exercises on conducting fish farmers meet.
			14	Case study on fish seed hatchery/fish farm
			15	Case study on fishermen co-operative society
			16	Formulation of fisheries extension programme
10	**FEES. 225**	**0+1=1**		**COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT**

			Practical	***PRACTICAL:***
			1	Structural and functional grammar;
			2	Meaning and process of communication,
			3	Verbal and non-verbal communication;
			4	Listening and note taking, writing skills, oral presentation skills;
			5	Field diary and lab record;
			6	Indexing, footnote and bibliographic procedures.
			7	Reading and comprehension of general and technical articles
			8	Précis writing, summarizing, abstracting
			9	Personality development- concepts, dimensions and significance
			10	Concept of success and failure, attitude and motivation, Self esteem
			11	Interpersonal relationship, goal setting
			12	Individual and group presentations
			13	Impromptu presentation
			14	Public speaking
			15	Group discussion
			16	Organizing seminars and conferences
	III Year			**V Semester**
1	**AQ. 312**	**2+1=3**		**FINFISH HATCHERY MANAGEMENT**
			Lecture	***THEORY :***
			1	Freshwater and marine fish seed resources.
			2	Natural breeding of finishes.
			3	Selection of riverine spawn collection sites, gears used and methods of collection.
			4	Spawn quality and quantity indices, advantages and disadvantages of riverine seed collection.
			5	Sexual maturity and breeding season of various cultivable species.
			6	Development of gametes in male and female.: Ovarian development
			7	Spermatogenesis and Oogenesis
			8	Types of fish egg and embryonic development.
			9	Bundh breeding: wet and dry bundhs, carp breeding operation in bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding.
			10	Comparison between Wet bund and dry bund
			11	Induced breeding of warm water finfishes, environmental factors affecting spawning and breeding, sympathetic breeding.
			12	Hypophysation of fishes, fish pituitary gland - its structure.
			13	Broodstock management
			14	Transportation of brood fishes.
			15	Synthetic hormones used for induced breeding of carps.
			16	Different types of fish hatcheries - Traditional, Chinese, glass jar and modern controlled hatcheries.
			17	Designing of circular hatchery for seed production of IMC
			18	Causes of mortalities of eggs and spawn, treatment of eggs.
			19	Spawn rearing techniques.
			20	Use of anesthetics in fish breeding and transport.
			21	Breeding techniques for Indian major carps and exotic carps
			22	Breeding techniques for Cold water fishes: Mahseer, Trout
			23	Breeding techniques for Tilapia
			24	Breeding techniques for cat fishes
			25	Breeding techniques for Mullet
			26	Breeding techniques for Milk fish
			27	Breeding techniques for Pearl spot
			28	Breeding techniques for Sea bass, Sea horse and grouper
			29	Breeding techniques for pacu, cobia, popanos, etc
			30	Breeding techniques for other indigenous species
			31	Multiple breeding of carps.

			32	Cryopreservation of fish gametes.
			Practical	**PRACTICAL:**
			1	Study of maturity stages in fish.
			2	Collection and preservation of fish pituitary gland,
			3	Preparation of hypophysial extract.
			4	Calculation of fecundity.
			5	Brood stock maintenance and selection of brood fishes for injection.
			6	Histological studies of ovary
			7	Histological studies testes.
			8	Different fish hatchery systems.
			9	Study of fish eggs and embryonic developmental stages.
			10	Identification of eggs, spawn, fry and fingerlings of different species.
			11	Fish seed and broodstock transportation.
			12	Use of anesthetics, disinfectants and antibiotics in fish breeding.
			13	Water quality monitoring in fish hatcheries and nurseries.
			14	Cryopreservation of fish gametes.
			15	Breeding of common finfishes.
			16	Larval rearing common finfishes.
2	**FRM. 317**	**1+1=2**		**ANATOMY AND BIOLOGY OF SHELLFISH**
			Lecture	***THEORY :***
			1-3	Study of external and internal organization of commercially important crustaceans and molluscs.
			4-5	Digestive system
			6	Respiratory system
			7	Circulatory system
			8	Nervous system
			9-10	Reproductive system
			11	Food and feeding habits
			12	Growth & moulting
			13	length – weight relationship
			14-15	Reproductive biology, larval stages
			16	Age and growth determination by direct and indirect methods.
			Practical	**PRACTICAL:**
			1-5	Study of Internal Organs commercially important crustaceans and mollusks
			6	Digestive
			7	Respiratory
			8	Circulatory
			9	Nervous
			10	Reproductive
			11	Study of food and feeding habits
			12	Analysis of gut contents
			13	Age and growth
			14	length - weight relationship and condition factor
			15-16	Reproductive biology: maturity stages, spawning periodicity, fecundity and larval stages.
3	**FRM. 318**	**2+1=3**		**MARINE FISHERIES**
			Lecture	***THEORY :***
			1-4	Classification and definition of fishery zones and fishery resources of world.
			5-8	Overview of marine fisheries resources of the world and India.
			9-12	Major exploited marine fisheries of India, their developmental history and present status.
			13-22	Important pelagic - demersal fish, shellfish and seaweed resources of India.

			23-28	Traditional, motorized and mechanized fisheries according to major gears.
			29-30	Potential marine fishery resources of the India's EEZ.
			31-32	GIS and Remote sensing in marine capture fishery.
			Practical	**PRACTICAL:**
			1-3	Visit to fish landing centres
			4-6	Observation and analysis of catches by major crafts and gears.
			7-12	Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data
			13-14	Participation in fishing cruises
			15-16	GIS and remote sensing in marine capture fishery.
4	**FRM. 319**	**2+1=3**		**FISH POPULATION DYNAMICS AND STOCK ASSESSMENT**
			Lecture	***THEORY :***
			1	The concept of population and unit stock
			2-3	Biological structure of fisheries resource in space and time.
			4	Indicators of dynamics in a fishery resource.
			5	Characteristics of unit and mixed stock
			6-7	Data requirements for stock assessment
			8	Segregation of stocks
			9	Principles of stock assessment
			10	Population age structure
			11	Theory of life tables
			12	Von Bertalanffy growth parameters
			13-14	Graphical models.
			15-16	Monte Cario Simulation model and ECOPATH mode
			17-18	Estimation of total fishing and natural mortality
			19	The concept of yield, yield in number and yield in weight, yield per recruit, yield curve.
			20	Yield models & CPUE
			21-22	The concept of Maximum Sustainable Yield and Maximum Economic Yield
			23	Biological symptoms of under-fishing and over-fishing.
			24	Growth over-fishing and recruitment over-fishing.
			25	Eumetric fishing
			26	Open access fisheries
			27-29	Fisheries regulations.
			30	Trawl selection and gillnet selection
			31-32	Analytical models of fish stocks.
			Practical	**PRACTICAL:**
			1	Study of length – weight relationship
			2	segregation of stock using direct methods.
			3	Study of analytical models
			4	Beverton and Holt model.
			5	VBGF
			6	Pauly's integrated methods
			7	graphical models
			8-9	Estimation of Z, F and M
			10	Estimation of net selectivity coefficient
			11	Fitting of surplus production model:
			12	Schaeffer model
			13	Fox model
			14	Study of yield isopleth diagrams.
			15-16	Micro-computer packages ELEFAN, FISAT.
5	**AAHM. 315**	**2+1=3**		**PHARMACOLOGY**
			Lecture	***THEORY :***

			1 - 3	Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature
			4	Scope of pharmacology in fishes
			5 - 7	Route of Administration and Method of application to fish
			8 - 10	Source of Drugs. Pharmacolotherapeutic classification of drugs.
		all	11 - 14	Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and Excretion of drugs.
			15 - 16	Factors influencing drug metabolism
		6 cover by Vijay	17 - 22	Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non receptor mediated action. Dose Response Relationship, half life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose
			23 - 25	Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs.
		26,27,28	26 - 28	Salient features in drug acting on digestive system, nervous system and cardiovascular system.
			29 - 30	Drugs used in fish transporation
		31,32	31- 32	Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry
			Practical	**PRACTICAL:**
			1	Introduction to Pharmacy
			2 - 4	Metrology, Prescription Writing, Preparation of drug solution
		3 Cover by Vijay	5 - 7	Source and chemical nature of drugs
		8,9	8- 9	Pharmacutical technology
		10,11	10 - 11	Bioassay of drugs
			12 - 14	Animal models in Pharmacological experiments
		15,16	15 - 16	Methods of application of drugs in fish
6	**AAHM. 316**	**1+1=2**		**FISH TOXICOLOGY**
			Lecture	***THEORY :***
			1	General Toxicology: Definitions, Branches of Toxicology,
			2	Historical developments,
			3	Classification of poison.
			4-5	Types of poisoning- Toxicity testing - Chronocity factor, Untoward effects
			6	Common causes,
			7	Diagnosis of poisoning,
			8	Factors modifying toxicity,
			9	Toxicokinetics, Toxicodynamics,
			10	General approaches to diagnosis and treatment of poisoning.
			11	Systemic Toxicology: Toxicity caused by metal and non-metals,
			12	Phytotoxins- Toxic principles of various alkaloids and toxic plants,
			13	Drug toxicity and toxicity caused by agrochemicals.
			14	Mycotoxins, Bacterial toxins.
			15	Collections and dispatch of specimens in Toxicological cases,
			16	Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish- Metabolism of toxic substances by aquatic organisms.
			Practical	**PRACTICAL:**
			1-8	Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe_3^+), Copper (Cu), Ammonia (ammonium ions) NH_4 Chloride (Cl^-), Phosphate ($P0_4$) Sulphate ($S0_4$) Flouride (Fl^-),
		9,10	9-10	Qualitative detection of Nitrite and Nitrate,
			11	Detection of hydrocyanic acid,

			12	Detection and Estimation of Mycotoxins,
		13	13	Test for detection of alkaloids,
			14-15	Estimation of LD_{5O} and ED_{5O}
			16	Demonstration of drug toxicity.
7	**AEM. 317**	**1+1=2**		**COASTAL ZONE MANAGEMENT**
			Lecture	***THEORY :***
			1	Estuaries, Wet lands and Lagoons, Living resources – Non living resources.
			2-3	Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems.
			4-5	Data Input, Data Management, Data Quality.
			6-7	Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification.
			8-9	Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations.
			10	CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application and case studies.
			11-12	Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM.
			13	Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection.
			14	Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry.
			15	Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries.
			16	Evaluation and Methodology; Social Impact Assessment and other developmental activities.
			Practical	**PRACTICAL:**
			1-5	Field visit to different coastal environments to study erosion of beaches,
			6-8	Identification of ecologically sensitive areas and protection,
			9	Study of CRZ, ICZM along the coastal belt,
			10	Study on implementation and violation of CRZ,
			11-13	Study of application of remote sensing and GIS,
			14-16	Project preparation of EIA.
8	**FE. 312**	**1+1=2**		**FISHING GEAR TECHNOLOGY**
			Lecture	***THEORY :***
			1	Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing
			2	Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears.
			3	Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG).
			4	Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears.
			5	Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material
			6	Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns.

			7	Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.
			8	Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines.
			9	Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system : British count, metric count, runnage system and their conversion.
			10	Methods of Preparation of knotted and knotless webbing;, advantage and disadvantages of knotted and knotless webbings.
			11	Shape of mesh: diamond; square hexagonal and their measurement.
			12	Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velacity, weather resistance, melting point and visibility. Chemical and Biological properties.
			13	Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy.
			14	Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation.
			15	Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl.
			16	Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board
			Practical	**PRACTICAL:**
			1	Study of net making tools
			2	Knots used in net making
			3	Hitches used in net making
			4	Methods of net making: a) Hand braiding,
			5	b) Chain mesh method,
			6	c) Loop methods of net making.
			7	Shaping of webbing: baiting, creasing and reducing mesh size step by step.
			8	Tailoring method : T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination.
			9	Joining of net pieces.
			10	Net mounting – a) hanging coefficient,
			11	Hung depth,
			12	Calculations for hanging coefficient and hung depth
			13	Selvedging.
			14	Methods of net mounting: a) reeving, b) stapling and
			15	c) Norselling.
			16	Mending and net shooter techniques.
9	**FEES. 316**	**1+1=2**		**FISHERIES CO-OPERATIVES AND MARKETING**
			Lectures	***THEORY :***
			1	Principles and objectives of co-operation, co-operative movement in fisheries in India
			2	Structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing.
			3	Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries;

			4	Returns, risk bearing ability and recovery in fisheries sector;
			5	Role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry.
			6	Basic accounting procedures, profit and loss account
			7	Introduction to marketing management
			8	Core marketing concepts: market structure, functions and types, marketing channels and supply chain,
			9	Marketing margins, marketing environment, marketing strategies,
			10	Product development and product mix, consumer behavior and marketing research.
			11	Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets
			12	Cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products;
			13	Trade liberalization and fisheries markets. Integrated marketing approach in fisheries.
			14	Sea food export case study on product and market diversification- export and import policies (fisheries).
			15	New product development and market segmentation
			16	Export and import policies relevant to fisheries sector.
			Practical	**PRACTICAL:**
			1	Developing questionnaire and conducting market surveys
			2	Analysis of primary and secondary market data.
			3	Exercises on equilibrium price for fish and fishery products;
			4	Estimation of demand using simple regression.
			5	Estimation of supply using simple regression.
			6	Analysis of credit schemes of banks and the government.
			7	Case studies of cooperatives.
			8	Visit to co-operative societies.
			9	Visit to commercial banks.
			10	Visit to fish markets
			11	Visit to organizations dealing with marketing of fish and fishery products.
			12	Pattern and Performance of India's Seafood Exports
			13-14	Case studies on product and market diversification.
			15-16	Case studies on competitiveness of Indian fish and fish products.
	III Year			**VI Semester**
1	**AQ. 323**	**1+1=2**		**INTRODUCTION TO BIOTECHNOLOGY AND BIOINFORMATICS**
			Lecture	***THEORY :***
			1	Biotechnology**:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture;
			2	Structural organization of prokaryotic and eukaryotic cell.
			3	Nucleic acids -structure, function and types,
			4	Concepts of gene and genetic code, transcription and translation, mutations and their implications.
			5	Post transcriptional modification and RNA processing.
			6	Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons.
			7	Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology – vaccines..
			8	Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology
			9	Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors.

			10	Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors.
			11	Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors.
			12	Concept of bioremediation of water, bioprocess engineering and bioprospecting.
			13	Bioinformatics**:** Introduction to Bioinformatics;
			14	Biological Databases and tools :
			15	Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents;
			16	Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.
			Practical	**PRACTICAL:**
			1	Study of structure of prokaryotes Cells
			2	Study of structure of Eukaryotes Cells
			3	Study on Model of protein Synthesis,
			4-6	Study of models of rDNA Technology,
			7-9	Study of models of Cell CultureTechnology,
			10-11	Isolation of Nucleic Acids
			12	Study of Restriction enzymes
			13	Study of Gel Electrophoresis
			14	Study of ELISA test
			15-16	DNA sequence analysis and comparison.
2	**AEM. 328**	**1+1=2**		**AQUATIC POLLUTION**
			Lectures	***THEORY :***
			1	Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment,
			2	Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies.
			3	Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse.
			4	Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget;
			5	Biological effects of organic matter.
			6	Excessive plant nutrients: Eutrophication; Red tides and fish kills.
			7	Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs);
			8	Bioaccumulation and impact on aquatic fauna and human health; toxicology.
			9	Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation.
			10	Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies.
			11	Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex;
			12	Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion;
			13	Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution.

			14	Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India.
			15	Monitoring and control of pollution: Biological indicators of pollution.
			16	Solid waste management.
			Practical	**PRACTICAL:**
			1	Physical characteristics of polluted waters; Colour, Odour, Turbidity.
			2	Determination of pH, salinity, alkalinity, hardness,
			3	Determination of BOD, COD,
			4	Determination of Hydrogen sulphide, Phosphates, Ammonia, Nitrates,
			5	Determination of Heavy metals and Oil and grease in water.
			6	Determination of pH, conductivity,
			7	Determination of organic carbon, nitrogen, phosphorus,
			8	Determination of heavy metals in sediments.
			9	Study of pathogenic and coliform bacteria. Bacteriological quality of water; Colliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters.
			12	Pollution flora and fauna: indicator species- algae, protozoa and insect larva.
			13-14	Methods of pesticide residue analysis in waters and fish tissue;
			15-16	Bioassay and toxicity study.
3	**FPT. 326**	**2+1=3**		**FISH PRODUCTS AND VALUE ADDITION**
			Lecture	***THEORY :***
			1	Principle of fish preservation and processing
			2-3	Processing of fish by traditional methods– salting,sundrying,smoking, marinading and fermentation.
			4	Theory of salting, methods of salting–wet salting and dry salting
			5	Drying and dehydration- theory,importance of water activity in relation to microbial growth.
			6	Sun drying and artificial drying- solar dryer
			7	Packaging and storage of salted and dried fish.
			8	Different types of spoilage in salt cured fish.
			9	Quality standard for salted and dryfish
			10	Fish preservation by smoking-chemical composition of wood smoke and their role in preservation.
			11	Methods of smoking and equipments used for smoking.
			12	Carcinogenic compound in wood and methods to remove them
			13-15	Hurdle technology in fish preservation and processing
			16	Fish and prawn pickles,
			17	Fish sauce and Fish paste,
			18	Traditional Indian fermented products
			19	Fermented fish products of Southeast Asia
			20-21	Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc.
			22-23	Fish muscle structure, myofibriller protein and their role in elasticity formati
			24-25	Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products.
			26	Value addition.
			27	Diversified fish products:battered and braided products-
			28-29	Fishfinger, fishcutlet,fish wafer,and fish souppowder etc
			30-31	Imitation products.
			32	HACCP in safe products production.
			Practical	**PRACTICAL:**
			1	Preparation of salted fish by different methods
			2-3	Preparation of dried fish
			4	Preparation of smoked fish
			5	Quality assessment of salted,dried and smoked fish

			6-7	Preparation of prawn & fish pickles.
			8	Preparation of fermented fish sauce and marinaded products.
			9-11	Preparation of surimi and surimi based products.
			12-14	Preparation of diversified and value added fish products.
			15-16	Quality assessment of market sample of dried and fermented fish products.
4	**FPT. 327**	**1+1=2**		**FISH BY-PRODUCTS AND WASTE UTILIZATION**
			Lecture	***THEORY :***
			1	Fish meal.Dryreductionandwetreductionmethods – specification – packaging and storage.
			2	Fish oil – body oil – extraction – purification – preservation – storage – application.
			3	Fish oil – liver oil – extraction – purification – preservation – storage – application.
			4	Shrimp wastes – chitin – chitosan production – uses.
			5	Fish protein concentrate
			6	Fish hydrolysate
			7	Partially hydrolyzed and deodorized fish meat,
			8	Functional fish protein concentrate and their incorporation to various products
			9	Fish silage – acid silage – fermented silage – application.
			10	Fishmaws & isinglass,
			11	Fish glue,fish gelatin pearl essence
			12	Shark leather, sharkfin rays
			13	Beach-de-mer.
			14	Biochemical and pharmaceutical products.
			15-16	Utilization of seaweeds: agar agar, algin, carrageenan
			Practical	**PRACTICAL:**
			1	Preparation of fish meal.
			2	Preparation of fish body oil.
			3	Preparation of fish liveroil
			4	Preparation of fish maws, isinglass
			5	Preparation of fishsilage & ensilage
			6	Preparation of fish glue
			7	Preparation of fish gelatin,
			8	Preparation of pearl essence
			9	Preparation of chitin, chitosan
			10	Preparation of fish manure
			11-13	Preparationof acid and fermented silage
			14	Preparation of fish protein concentrate
			15-16	Preparation of fish hydrolysate.
5	**FPT. 328**	**2+1=3**		**MICROBIOLOGY OF FISH AND FISHERY PRODUCTS**
			Lecture	***THEORY :***
			1	Introduction and history of microorganisms in foods.
			2	Role and significance of microorganisms in nature and in foods.
			3-5	Sources and types of microorganisms in fish and fishery products.
			6-7	Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food.
			8-12	Enumeration of microorganisms in food by conventional techniques.
			13-16	Enumeration of microorganisms in food by rapid technique.
			17-19	Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals.
			20-21	Microbiology and spoilage of fresh, semi processed and processed fish and fishery products.
			22-23	Indicators of microbiological quality of fish and fishery products.

			24-28	Food borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention.
			29	Other biological hazards associated with fish and fishery products-
			30-32	Marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.
			Practical	**PRACTICAL:**
			1	Sampling and processing of samples for microbiological investigation
			2_4	Enumeration of microorganisms associated with finfish, shellfish, water and ice.
			5	Testing of water for potability
			6_10	Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae, Vibrio parahaemolyticus,* , *E coli* , *Salmonella* , *Listeriamonocytogenes* and faecal streptococci.
			11_12	Biochemical tests for characterization of bacteria.
			13_15	Molecular methods for the detection of pathogenic microorganisms
			16	Determination of MIC and MCC of chemical preservatives.
6	**FE. 323**	**1+1=2**		**FISHING TECHNOLOGY**
			Lecture	***THEORY :***
			1	Structure of various commercial fishing gears.
			2	Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements.
			3	Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt.
			4	Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels.
			5	Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid water trawling.
			6	Constructional details of single boat purse seine; two boat purse seine and method of operation.
			7	Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet,
			8	Operation of gillnet: set gillnetting; drift gillnetting; bottom , mid water and pelagic gillnetting.
			9	Line fishing: Types of hooks; structure and size of hooks.
			10	Constructional details of long line, tuna long line, vertical long line, pole & line and trolling line.
			11	Operation of long line: set and drift long lining: bottom, mid water and pelagic long lining; jigging.
			12	Operation of beach seine, boat seine and traps.
			13	Selectivity in fishing gear and by catch reducing devices.
			14	Deck equipments – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps.
			15	Fishing equipment: Fish finder, GPS navigator, sonar, net sonde,
			16	Gear monitoring equipment.
			Practical	**PRACTICAL:**
			1	**Survey of fishing gears: a)** Trawl,
			2	b) Gillnet,
			3	c) Long line,
			4	d) Purse seine.
			5	**Rigging of: a)** Trawl net,
			6	b) Purse seine net,
			7	c) Gillnet,
			8	d) Hooks,

			9	e) Lines.
			10	**Commercial fishing techniques: a)** Bottom Trawling,
			11	b) Side and Stern trawling
			12	c) Purse seining,
			13	d) Gillnetting,
			14	e) Line fishing,
			15	f) Cast net fishing,
			16	g) Trap fishing.
7	**FE. 324**	**2+1=3**		**REFRIGERATION AND EQUIPMENT ENGINEERING**
			Lecture	***THEORY :***
			1	Fundamentals: Force, work, power, energy, volume, pressure, temperature.
			2	Heat, specific heat, sensible heat, latent heat, comparison between heat and work-A path function.
			3	Thermodynamics: Laws of Thermodynamics, Laws of perfect gases,
			4	Thermodynamic processes,
			5	Application of First and Second law of Thermodynamics in refrigeration,
			6	Thermodynamics cycle, entropy, enthalpy.
			7	Refrigeration: History of refrigeration, Definition, principle, classification,
			8	Types of refrigeration systems i.e., a)Air refrigeration
			9	b) Vapour absorption refrigeration system.
			10	c) Vapour compression refrigeration system.
			11	Refrigeration plant: Layout of refrigeration plant, Construction.
			12	Insulating materials used for the cold storage construction, Frozen product storage capacity of cold storage, usage of Ante-room.
			13	Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems,
			14	Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle,
			15	Actual refrigeration cycle.
			16	Compressors: Definition, Types of compressor, construction, working principle advantages and disadvantages.
			17	Evaporator: Definition, Types of Evaporator, construction, working principle advantages and disadvantages.
			18	Condenser: Definition, Types of Condenser, Cooling Towers, construction, working principle, advantages and disadvantages.
			19	Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages.
			20	Refrigerant: Primary refrigerant, secondary refrigerant
			21	Ideal refrigerant properties, leakage detection.
			22	Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting.
			23	Ice-plant: Ice plant planning Brine tank construction, preparation of brine ,Types of ice, Storing of ice, Equipments used in ice plants.
			24	Freezers: Definition, Design and construction of freezers i.e. Plate freezer, Blast freezer,
			25	Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold.
			26	Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated sea water (RSW), Chilled sea water (CSW). Refrigerated transport.
			27	Cooling load: Unit of refrigeration, coefficient of performance (C.O.P),Refrigeration effect, study and use of Psychometric chart.

			28	Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipments.
			29	Theory of machines: Transmission of power, friction wheels, shaft , gears, belt and Chain drive.
			30	Study of equipments used in fish processing with particular reference to canning, sausage, freeze drying and irradiation.
			31	Maintenance: Definition, Types of maintenance, general maintenance of freezing plant,
			32	General maintenance of cold storage and ice plant.
			Practical	**PRACTICAL:**
			1	Drawing of Refrigeration and Fish processing machineries plant layout
			2	Graphically represented symbols used in refrigeration
			3	Handling and operation of a) Compressors,
			4	b) Condensers,
			5	c) Evaporators
			6	d) Expansion valves,
			7	e) Low and high pressure switches.
			8	Study of auxiliary equipments: a) Receiver,
			9	b) Oil charging,
			10	c) Refrigerant charging and gas purging,
			11	d) Oil draining, types of defrosting.
			12	Power transmission line diagram of different fish processing machineries.
			13	Visit to processing plant refrigeration plant,
			14	Visit to ice plant,
			15	Visit to fishing harbor to study the fish hold, refrigerated fish rooms.
			16	Calculation on refrigeration effect and cooling load.

8	**FE. 325**	**1+1=2**		**NAVIGATION AND SEAMANSHIP**
			Lectures	***THEORY :***
			1	Principles of navigation –terms and definitions, finding positions and method of position fixing magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay pointspelorus and azimuth mirror, method of observation.
			2	Sextant -parts and functions, finding adjustable and non adjustable errors and principles and use.
			3	Hand lead line –construction and markings and method of taking soundings.
			4	Types of speed logs –patent log, impeller log
			5	Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions.
			6	The IALA-buoy age systems, cardinal and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system ,storm signals stations
			7	Indian coasts, Fog signals, types and methods
			8	Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea.
			9	Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS
			10	Principles of seamanship- Causes fire at sea, fire prevention on board the vessel and method of fire fighting at sea and recommended fire fighting appliances,
			11	Life saving appliances –life jackets, life buoys and method of operations and contents, SART and EPIRB.
			12	Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law.
			13	Preparing vessel to face heavy weather.
			14	Temporary repairs for leaks constructions of steering system and rigging emergency jury rudder .types of anchors and their applications.
			15	Selection of suitable anchorage , procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures,
			16	Axial thrust , transverse thrust mooring and securing the vessel to the jetty rigging fenders and gangways , and method of leaving vessels from the birth.
			Practical	**PRACTICAL:**
			1	Anchoring,
			2	Coming along side the berth and leaving,
			3	Practicing the different types of knots and wire splices,
			4	Use of magnetic compass.
			5	Use of GPS and Echo-sounder.
			6	CHART WORK-Finding positions by latitudes
			7	Finding positions by longitudes
			8	Finding positions by position lines by cross bearing,
			9	Finding positions by horizontal sextant angles,
			10	Finding positions by vertical sextant angle
			11	Finding positions by running fix,
			12	Finding positions by speed,
			13	Finding positions by distance and time
			14	Findings set and drift of current
			15	Findings course made good speed made good and steering course and

			16	Finding position by counter acting the current observation of RADAR

9	**FEES. 327**	**1+0=1**		**FISHERIES POLICY AND LAW**
			Lecture	***THEORY :***
			1	Introduction to public administration, principles of organization and management of public enterprise.
			2	Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels.
			3	Present relevance of past fisheries policies and recent policies in fisheries sector.
			4	Functions and powers of functionaries of department of fisheries, corporations and cooperatives.
			5	Different central and state level fisheries institutions.
			6	Role of Central and State Government in the regulatory activities of Aquaculture and fisheries; Implementation of community based resource management plans.
			7	Historical review of fisheries development and management in India and world.
			8	International agencies / organizations for promotion of fisheries worldwide.
			9	Fisheries legislation: Overview of fisheries and aquaculture legislations in India.
			10	Indian Fisheries Act, 1897;
			11	Environmental legislations- Water Act, Air Act and Environmental (Protection) Act in India; International environmental legislation and its impact on fisheries.
			12	Laws relating to conservation and management of fishery resources in marine and inland sectors.
			13	Recent changes in land reforms. Land reforms legislation as applicable to aquaculture. Judicial judgments relating to Aquaculture.
			14	Objectives, functions and authority of fishery regulatory agencies like coastal regulatory zone (CRZ) and Aquaculture Authority of India
			15	Brackishwater Aquaculture Act, Marine Fisheries Policy, Laws related to fish products and marketing
			16	International Law of the Seas and international commissions on fisheries and their impact.
10	**FEES. 328**	**1+0=1**		**FISHERIES BUSINESS MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT**
			Lecture	***THEORY :***
			1	Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise
			2	Motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up;
			3	Managing competition; entrepreneurship development programs; Generation, incubation and commercialization of ideas and innovations.
			4	Government schemes and incentives for promotion of entrepreneurship.
			5	Preparation of enterprise budget for integrated fish farming; Infrastructural and other financial requirement for fishery entrepreneurship
			6	Fiscal and monitory policies and its impact on entrepreneurship.
			7	Government policy on Small and Medium Enterprises (SMEs) / SSIs.
			8	Venture capital; Contract farming and joint ventures; public-private partnerships
			9	Overview of fisheries inputs industry. Characteristics of Indian fisheries processing and export industry.
			10	Introduction to fish business management- Concept of management, management process (planning, organising, staffing, leading and controlling)

			11	Organizational behavior; human resource planning; new dimensions in fish business environment and policies.
			12	Accounting procedures of fish business entity. Emerging trends in fish production, processing, marketing and exports.
			13	Assessing overall business environment in the Indian economy.
			14	Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs.
			15	Globalisation and the emerging business /entrepreneurial environment.
			16	Social Responsibility of Business.
	IV Year			**VII Semester**
1	READY 411	**0+20=20**		**STUDENT READY PROGRAMME**
		0+10=10		a) IN-PLANT ATTACHMENT (FOR 8 WEEKS)
		0+8=8		b) RURAL FISHERIES WORK EXPERIENCE PROG. (FOR 8 WEEKS)
		0+2=2		c) STUDY TOUR (IN AND OUTSIDE STATE) (FOR 4 WEEKS)
	IV Year			**VIII Semester**
1	**FE. 426**	**2+1=3**		**AQUACULTURE ENGINEERING**
			Lecture	***THEORY :***
			1	Fish Farm- Definition, objectives; Farm types – Freshwater, brackish water and marine farms.
			2	Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, Detailed survey viz., site condition, topography, soil characteristics.
			3	Land Surveying- definition, principles of surveying, classification of
			4	Instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey.
			5	Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass.
			6	Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling.
			7	Plane table surveying- instruments required, working operation, methods.
			8	Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour.
			9	Calculation of area of regular and irregular plane surfaces,
			10	Trapezoidal and Simpson's rule, volume of regular and irregular shape as applied to stacks and heaps, calculation of volume of pond.
			11	Earth work calculations- excavation, embankment, longitudinal slope and cross slope,
			12	Calculation of volume of earth work as applied to roads and channels.
			13	Soil and its properties- classification of soil;
			14	Soil sampling methods; three phase system of soil, definitions of soil properties andpermeability of soil.
			15	Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system.
			16	Planning of fish ponds, layout planning, materials planning, manual planning,
			17	Comparison of square and rectangular ponds, large and small ponds
			18	Types of ponds; nursing ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry; shape, size, bottom slope of pond *etc.,*
			19	construction ponds viz., marking, excavation etc.,

			20	Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes.
			21	Water distribution system- canal, types of canals; feeder canal, diversion canal etc.,Pipe line system,
			22	Water control structures- types of inlet and out let and their construction. Water budget equation,
			23	Water control structures- types of inlet and out let and their construction. Water budget equation,
			24	Pond drainage system; seepage and the methods used for seepage control,
			25	Evaporation; factors affecting evaporation, erosion of soil in dykes and its control.
			26	Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc.,
			27	Hatcheries- site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc,
			28	Raceway culture system- site selection, layout plan,
			29	Types of raceway culture system viz.,parallel system, series system etc.,
			30	Aerators- principles, classification of aerators and placement aerators.
			31	Pumps- purpose of pumping, types, selection of pump, total head, horse power calculation.
			32	Filters- types and constructions.
			Practical	**PRACTICAL:**
			1	Evaluation of potential site for aquculture
			2	Land Survey: a) Chain surveying.
			3	b) Compass Survey.
			4	c) Leveling.
			5	d) Plane table surveying
			6	e) Countouring
			7	Soil analysis for farm construction.
			8	Design and layout plan of fresh water farms.
			9	Design and layout plan of brackish water farms.
			10	Design and layout plan of hatcheries.
			11	Design of farm structure: a) Ponds
			12	Design of farm structure: b) Dykes
			13	Design of farm structure: c) Channels
			14	Earth work calculations.
			15	Water requirement calculation.
			16	Visit to different types of farms.
2	**AAHM. 427**	**2+1=3**		**MICROBIAL AND PARASITIC DISEASES OF FISH AND SHELLFISH**
			Lecture	***THEORY :***
			1-11	General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish.
			12	OIE listed diseases.
			13	Disease surveillance and reporting.
			14	Quarantine and health certification in aquaculture.
			15-20	Health management strategies in Aquaculture: Vaccines, Immuno-stimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices.
			21-23	SPF and SPR stocks –development and application.
			24-27	Bio-security principles, Sanitary and phytosanitary Agreement, Disease control through environmental management.

			28-29	Importance of Biofilm, Biofloc, Periphyton in aquatic Health Management, Zoonotic diseases.
			30-32	Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, Rapid diagnostic methods.
			Practical	**PRACTICAL:**
			1	General procedure for disease diagnosis.
			2-3	Methods of sampling fish and shellfish for disease diagnosis.
			4-5	Taxonomy, lifecycle and identification of fish and shellfish parasites.
			6	Sampling, preparation of media and culture of pathogenic bacteria:
			7	Techniques for bacterial classification.
			8-10	Techniques in disease diagnosis: Microbiological, haematological, Histopathological, immunological, molecular techniques and Biochemical tests.
			11	Agglutination test;
			12	Challenge tests;
			13	Purification of virus;
			14-15	Stress related study of fish and shellfish;
			16	Disease treatment.
3	**FPT. 429**	**2+1=3**		**QUALITY ASSURANCE OF FISH AND FISHERY PRODUCTS**
			Lecture	***THEORY :***
			1	Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters.
			2	Pre-harvest and post harvest factors affecting quality.
			3	Assessment of quality changes in fresh and iced fish.
			4	Quality changes during processing.
			5-8	Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze dried products
			9-10	Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design.
			11-12	Food laws and standards, national and international legislation, mandatory and non mandatory standards.
			13-14	Role of export inspection council & export inspection agency and MPEDA in fish and fishery products.
			14-16	Executive instructions on fish and fishery products, Legislation for export quality assurance in India
			17-18	Certification system for fish & fishery products.
			19-20	Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish & fishery products for export. Complaint handling procedure on fish and fishery products.
			21-22	Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues.
			23	GOI notifications on fish and fishery products.
			24	General requirements for export of fish and fishery products to the EU.
			25-27	International regulatory framework for fish safety and quality. Prerequisites to HACCP, Labelling for product traceability and Labelling requirements-National and international, legislation on labelling, components of traceability code-nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people.
			28	EU legislation on traceability of fish and fish products, Assessment of food safety programmes.
			29	The HACCP for seafood industries and protection of food from adulterants.
			30	Standards for sea foods.FSSA, FDA, ISO

			31	Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability
			32	Waste management in seafood processing.
			Practical	**PRACTICAL:**
			1-3	Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods.
			4	Chlorination and Hardness estimations.
			5-8	Quality analysis of canned, frozen, cured and pickled fish products.
			9	Quality tests for tin and corrugated containers.
			10	Assessment of plant, equipment sanitation and personnel hygiene
			11-12	Detection of filth and extraneous matter in traditional processed products.
4	**READY 422**	**6+23=29**		**STUDENT READY EXPERIENTIAL MODULE**
				(concurrent with the semester)
				This will include capacity building and skill development of the students in planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency.
		0+5=5		**a) SKILL DEVELOPMENT (FOR ONE WEEK)**
		0+12=12		**EXPERIENTIAL LEARNING PROGRAMME**
5		**0+2=2**		**PROJECT WORK**
6		**0+1=1**		SEMINAR