# MAHARASHTRA ANIMAL AND FISHERY SCIENCES UNIVERSITY, NAGPUR

## FACULTY OF FISHERIES

## Semester Wise Course Distribution and Lecture Schedule

## FOR

## BACHELOR OF FISHERIES SCIENCE (B.F.Sc.)

## DEGREE COURSE

**SEMESTER-WISE COURSE DISTRIBUTION AND LECTURE SCHEDULE**

| Sl.No. | Course Code | Course Title | Credit Hours | Total Credit hours |
|---|---|---|---|---|
| **I Semester** | | | | |
| 1. | BSC.111 | Deeksharambh* | 2(0+2) | **23(10+13) + 2 NG** |
| 2. | AQ.111 | Freshwater Aquaculture | 3(2+1) | |
| 3. | FRM.111 | Taxonomy of Commercially Important Fish and Shellfish | 3(1+2) | |
| 4. | AEM.111 | Soil and Water Chemistry | 3(2+1) | |
| 5. | AEM.112 | Meteorology and Geography | 2(1+1) | |
| 6. | AAHM.111 | Fundamental Microbiology | 2(1+1) | |
| 7. | BSC.112 | Farming Based Livelihood Systems | 3(2+1) | |
| 8. | BSC.113 | Communication Skills | 2(1+1) | |
| 9. | BSC.114 | NSS-I | 1(0+1) | |
| 10. | SEC.111 | Aquarium Making, Decoration and Management | 2(0+2) | |
| 11. | SEC.112 | Analytical Techniques | 2(0+2) | |
| **II Semester** | | | | |
| 1. | AQ.122 | Fish and Shellfish Breeding and Hatchery Management | 3(2+1) | **24(12+12)** |
| 2. | FRM.122 | Anatomy and Biology of Finfish and Shellfish | 3(2+1) | |
| 3. | FRM.123 | Physiology of Finfish and Shellfish | 3(2+1) | |
| 4. | AEM.123 | Limnology | 2(1+1) | |
| 5. | BSC.125 | Entrepreneurship Development and Business Management | 3(2+1) | |
| 6. | BSC.126 | Environmental Studies and Disaster Management | 3(2+1) | |
| 7. | BSC.127 | Personality Development | 2(1+1) | |
| 8. | BSC.128 | NSS-II | 1(0+1) | |
| 9. | SEC.123 | Fish Breeding and Hatchery Operation | 2(0+2) | |
| 10. | SEC.124 | Fish Handling, Preservation and Value addition | 2(0+2) | |
| **Post Semester-II Exit option forward of UG-Certificate)** | | | | |
| 1. | INT.121 | Internship*** | 10 (0+10) | **10 (0+10)** |

| Sl.No. | Course Code | Course Title | Credit Hours | Total Credit hours |
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| **III Semester** | | | | |
| 1. | AQ.213 | Coastal Aquaculture and Mariculture | 3(2+1) | **22(11+11)** |
| 2. | FRM.214 | Inland Fisheries | 2(1+1) | |
| 3. | FE.211 | Fishing Craft Technology | 2(1+1) | |
| 4. | FPT.211 | Fundamentals of Biochemistry and Food Chemistry | 3(2+1) | |
| 5. | FEES.211 | Fisheries Extension | 2(1+1) | |
| 6. | BSC.219 | Agriculture Marketing and Trade | 3(2+1) | |
| 7. | BSC.211 | Agricultural Informatics and Artificial Intelligence | 3(2+1) | |
| 8. | BSC.212 | Physical Education, First Aid, Yoga Practice and Meditation | 2(0+2) | |
| 9. | SEC.215 | Fish Market Survey and Value Chain Analysis | 2(0+2) | |
| **IV Semester** | | | | |
| 1. | AQ.224 | Fish Nutrition and Feed Technology | 3(2+1) | **22(12+10)** |
| 2. | AQ.225 | Breeding and Culture of Ornamental Fish | 2(1+1) | |
| 3. | AQ.226 | Live Food Organisms for Fish and Shellfish | 2(1+1) | |
| 4. | FRM.225 | Marine Fisheries | 2(1+1) | |
| 5. | AAHM.222 | Fish and Shellfish Diseases and Treatment | 3(2+1) | |
| 6. | FE.222 | Fishing and Gear Technology | 3(2+1) | |
| 7. | FPT.222 | Post-Harvest Handling and Preservation | 2(1+1) | |
| 8. | FPT.223 | Fish Products, By-products, Value Addition and Waste Management | 3(2+1) | |
| 9. | SEC. 226 | Net Making and Mending | 2(0+2) | |
| **Post Semester IV (Exit option forward of UG-Diploma)** | | | | |
| 1. | INT.222 | Internship**** | 10 (0+10) | **10 (0+10)** |
| **Sl.No.** | **Course Code** | **Course Title** | **Credit Hours** | **Total Credit hours** |
| **V Semester** | | | | |
| 1. | AQ.317 | Fish Genetics and Breeding | 2(1+1) | **21(12+9) + 2 NG** |
| 2. | FRM.316 | Fish Population Dynamics and Stock Assessment | 2(1+1) | |
| 3. | AEM.314 | Aquatic Ecology and Biodiversity | 2(1+1) | |
| 4. | AAHM.313 | Pharmacology and Toxicology | 3(2+1) | |
| 5. | AAHM.314 | Fish Immunology | 2(1+1) | |
| 6. | FPT.314 | Fish Freezing Technology | 2(1+1) | |
| 7. | FPT.315 | Fish Canning Technology and Packaging | 2(1+1) | |
| 8. | FE.313 | Aquaculture Engineering | 3(2+1) | |

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| 9. | FEES.312 | Statistical Methods | 3(2+1) | |
| 10. | BSC.313 | Education Tour* | 2(0+2) | |
| **VI Semester** | | | | |
| 1. | AQ.328 | Fish Biotechnology and Bioinformatics | 2(1+1) | **20(11+9)** |
| 2. | AEM.325 | Coastal Zone Management | 2(1+1) | |
| 3. | AEM.326 | Marine Biology | 2(1+1) | |
| 4. | AAHM.325 | Therapeutics in Aquaculture | 2(1+1) | |
| 5. | FPT.326 | Microbiology of Fish and Fisheries Products | 2(1+1) | |
| 6. | FE.324 | Refrigeration and Equipment Engineering | 2(1+1) | |
| 7. | FE.325 | Navigation and Seamanship | 2(1+1) | |
| 8. | FEES.323 | Fisheries Economics | 3(2+1) | |
| 9. | FEES.324 | Fisheries Policy and Laws | 1(1+0) | |
| 10. | FEES.325 | Fisheries Co-operative and Marketing | 2(1+1) | |

| **Sl.No.** | **Course Code** | **Course Title** | **Credit Hours** | **Total Credit hours** |
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| **VII Semester** | | | | |
| **Elective Courses (Major)** | | | | |
| 1. | AQ.419 | Open-water Aquaculture | 3(2+1) | **12** |
| 2. | FRM.417 | Sustainable Fisheries Management and Conservation | 3(2+1) | |
| 3. | AEM.417 | Fishery Oceanography | 3(2+1) | |
| 4. | FPT.417 | Quality Assurance of Fish and Fishery Products | 3(2+1) | |
| 5. | AQ.411 | Smart Aquaculture Production Systems | 3(2+1) | |
| 6. | AAHM.416 | Fish and Shellfish Pathology | 3(2+1) | |
| 7. | AAHM.417 | Disease Diagnostic Techniques | 3(2+1) | |
| 8. | AEM.419 | Aquatic Pollution | 3 (2+1) | |
| 9. | AEM.411 | Analytical Techniques in Aquatic Environmental Studies | 3(2+1) | |
| **Elective Courses (Minor)** | | | | |
| 1. | AQ.412 | Coldwater Aquaculture and Recreational Fisheries | 2(1+1) | **8** |
| 2. | AEM.418 | Climate Change and its Impact on Fisheries | 2(2+0) | |
| 3. | FE.416 | Responsible and Sustainable Fishing Methods | 2 (1+1) | |
| 4. | FEES.416 | ICT in Fisheries | 2(1+1) | |
| 5. | AEM.412 | Aquatic Microbiology | 2(1+1) | |
| 6. | FE.417 | GIS and Remote Sensing in Fisheries | 2 (1+1) | |

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| 7. | FPT.418 | Principles and Techniques of Seafood Analysis | 2(1+1) | |
| 8. | FPT.419 | Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products | 2(1+1) | |
| 9. | FEES.417 | Marketing Intelligence and Business Analysis | 2(1+1) | |
| **Note:** *Skill Enhancement Courses & Elective (Major & Minor) courses will be offered considering the significance of regional demands and local needs.* | | | | |
| **VIII Semester (Student READY)** | | | | |
| Student opting for 4-year B. F. Sc. A Student READY (Students Entrepreneurship Awareness Development Yojana) Program on In-plant /Industry Attachment/Rural Fisheries Work Experience (RFWE) Program/ Experiential Learning Program (ELP) / Project Work & Seminar will be undertaken as follows. | | | | |
| 1. | READY.421 | In-plant/Industry Attachment | 5(0+5) | **20(0+20)** |
| 2. | READY.422 | Rural Fisheries Work Experience (RFWE) Program | 6(0+6) | |
| 3. | READY.423 | Experiential Learning Program (ELP) | 6(0+6) | |
| 4. | READY.424 | Project Work & Seminar | 3(0+3) | |

**Semester-wise Course Contents of Sixth Dean Syllabus of B.F.Sc.**

| **Semester-wise Course Contents of VI Dean Syllabus of B.F.Sc.** | | | | |
|---|---|---|---|---|
| ***Sr. No.*** | ***Course code*** | ***Credit*** | ***Topic no.*** | ***Title and Content*** |
| **1** | **2** | **3** | **4** | **5** |
| **I Year** | | | | **I Semester** |
| **1** | BSC.111 | **0+2=2** | | DEEKSHARAMBH |
| | | | ***PRACTICAL:*** | |
| | | | 1-3 | Discussions on operational framework of academic process in university, as well as interactions with academic and research managers of the University |
| | | | 4-6 | Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences |
| | | | 7-09 | Students shall be made aware about the field of food processing, the industry, production systems, importance of nutrition, packaging, quality issues involved, shelf life and the legal standards available using simple day to day examples. |
| | | | 10-11 | In addition, the students shall be exposed to the job opportunities at various levels like production, product development, entrepreneurship opportunities and research opportunities that are existing in this area of food processing technology. |
| | | | 12-13 | The students will be encouraged to develop deep |

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| | | | | interest in the field in which now they have entered. It will also make it clear about the skill enhancement courses that they need to choose during the study to decide their future. |
| | | | 14-17 | Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences |
| | | | 18-21 | Activities to enhance cultural Integration of students from different backgrounds. |
| | | | 22-25 | Field visits to related fields/ establishments |
| | | | 26-32 | Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills |

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| **2** | **AQ. 111** | **2+1=3** | **FRESHWATER AQUACULTURE** | |
| | | | ***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 etc. |
| | | | 7 | Rearing pond management -control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, supplementary feeding etc. |
| | | | 8 | Grow-out ponds management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding etc. |
| | | | 9 | Water quality management. |
| | | | 10 | Selection of fish seed. |
| | | | 11 | Conditioning of fish seed. |
| | | | 12 | Transportation of seed. |
| | | | 13 | Acclimatisation of seed. |

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| | | | 14 | Culture methods of Indian major carps, exotic carps. |
| | | | 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 species - Medium and minor carps, catfishes and murrels. |
| | | | 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 | Composite fish culture system of Indian and exotic carps-competition and compatibility. |
| | | | 26 | Exotic fish species introduced to India and its impact on indigenous fish fauna. |
| | | | 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*** | |
| | | | 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 |

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| | | | | 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 |

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| **3** | **FRM.111** | **1+2=3** | | **TAXONOMY OF COMMERCIALLY IMPORTANT FISH AND SHELLFISH** |
| | | | ***THEORY*** | |
| | | | 1 | Principles of taxonomy. |
| | | | 2 | Nomenclature, types |
| | | | 3 | Classification and interrelationships and Criteria for generic and specific identification. |
| | | | 4-5 | Morphological, morphometric and meristic characteristics of taxonomic significance. |
| | | | 6-7 | Major taxa of inland and marine fishes up to family level. |
| | | | 8-9 | Commercially important freshwater and marine fishes of India and their morphological characteristics. |
| | | | 10 | Introduction to modern taxonomic tools: Karyo-taxonomy, DNA barcoding, protein analysis and DNA polymorphism. |
| | | | 11-13 | Study of external morphology and meristic characteristics of crustacea and mollusca. |
| | | | 14-16 | Classification of crustacea and mollusca up to the level of species with examples of commercially important species. |
| | | | ***PRACTICAL*** | |
| | | | 1-8 | Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. |
| | | | 9-11 | Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyo-taxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism |
| | | | 12-17 | Visit to fish landing centres to study commercially |

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| | | | | important fishes and catch composition. |
| | | | 18-28 | Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, and cephalopods from natural habitats. |
| | | | 29-32 | Field visits for collection and study of commercially important shellfish. |

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| **4** | **AEM.111** | **2+1=3** | | **SOIL AND WATER CHEMISTRY** |
| | | | ***THEORY*** | |
| | | | 1-4 | Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. |
| | | | 5-9 | Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve, nomograph. |
| | | | 10-12 | Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. |
| | | | 13-14 | Composition of waters: surface water, ground water and sea water. |
| | | | 15 | Dissolved gasses: Factors affecting natural waters. |
| | | | 16 | Acid, base, salts, Hydrogen ions, modern concept of pH and buffer. |
| | | | 17 | Water analysis: collection and preservation of water samples. |
| | | | 18-20 | Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. |
| | | | 21 | Water quality criteria/ requirements for Aquaculture. |
| | | | 22 | Soil Chemistry: Origin and nature of soils. |
| | | | 23 | Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity. |
| | | | 24 | Soil types and their distribution. |
| | | | 25 | Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. |
| | | | 26 | Soil reaction: acidity, alkalinity, conductivity, redox - potential. |
| | | | 27 | Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. |

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| | | | 28 | Saline soils, Alkali soils, acid sulphate soils, iron pyrites, and soil reclamation. |
| | | | 29 | Soil analysis: collection and preparation of soil samples, determination of soil texture, water holding capacity, pH, conductivity, organic carbon, 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*** | |
| | | | 1-3 | Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, 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. |
| | | | 5-7 | Water analysis: measurement of temperature, turbidity, determination of pH and EC. |
| | | | 8-11 | Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO2 . |
| | | | 12 | Determination of total alkalinity, hardness. |
| | | | 13 | Determination of inorganic nitrogen, and phosphorus. |
| | | | 14-16 | Soil analysis: Determination of soil texture, soil pH, conductivity, soil available nitrogen, available phosphorus, and organic carbon. |

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| **5** | **AEM.112** | **1+1=2** | | **METEOROLOGY AND GEOGRAPHY** |
| | | | ***THEORY*** | |
| | | | 1 | Nature of Atmosphere: weather and climate. |
| | | | 2 | Composition of atmosphere; structure of atmosphere. |
| | | | 3 | Heat energy of atmosphere: the process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of the atmosphere. |
| | | | 4 | Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. |
| | | | 5 | Humidity and water vapour: the relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements. atmosphere; evaporation. |
| | | | 6 | Condensation and precipitation: process of conditions of condensation, forms of condensation. |

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| | | | 7 | Precipitation; forms of precipitation, measurement of precipitation; rainfall in India. |
| | | | 8 | Clouds and thunderstorms: amount of cloudiness; ceiling; lassification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms. |
| | | | 9 | Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units;pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients. |
| | | | 10 | Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. |
| | | | 11 | Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. |
| | | | 12 | Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning. |
| | | | 13 | Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. |
| | | | 14 | Effects of climate change on fisheries sector. |
| | | | 15 | Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles. |
| | | | 16 | Model globe, maps and different types of projections; cartography; landscape. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Site selections for meteorological observatory |
| | | | 2 | Plan layout of meteorological observatory |
| | | | 3 | Graphic representation of the structure of atmosphere; physical layering and compositional layering. |
| | | | 4-5 | Temperature instruments: simple thermometers; six's Max-Min Thermometer; thermograph. |
| | | | 6 | Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. |
| | | | 7 | Precipitation: measurement of rainfall using rain gauge. |
| | | | 8-9 | 'Atmospheric pressure measurement: Fortin's mercurial barometer; Aneroid barometer. |
| | | | 10-11 | Wind observation and measurement: wind vane; cup anemometer. |
| | | | 12-13 | Mapping Indian monsoons: south-west monsoon and |

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| | | | | rainfall in June, North-east monsoon and rainfall in December; isohyets- |
| | | | 14 | Geography: The Earth: diagrammatic representation of shape, size, structure. |
| | | | 15 | Zones, latitudes, longitudes and great circles. |
| | | | 16 | Geographical terms used in landscape. |

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| **6** | **AAHM.111** | **1+1=2** | | **FUNDAMENTAL MICROBIOLOGY** |
| | | | ***THEORY*** | |
| | | | 1 | Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogrdasky. |
| | | | 2 | Microscopy- Principle and construction of brightfield, dark field, phase contrast, stereo, SEM and TEM |
| | | | 3 | Microbial taxonomy–Bergy's and molecular taxonomy. Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. |
| | | | 4 | General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae.Eukaryotes – Diagnostic features and importance of fungi and protozoa. |
| | | | 5 | Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining. |
| | | | 6 | Enumeration of micro-organisms, culture preservation methods. |
| | | | 7-8 | Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physicochemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. |
| | | | 9-10 | Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids- types and their importance. Mutation –types and significance. |
| | | | 11 | Microbial ecology: Introduction and types of interaction, extremophiles and their significance. Aquatic Microbiology: Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses. |

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| | | | 12 | Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment.Influence of physical, chemical and biological factors on aquatic microbes |
| | | | 13 | Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. |
| | | | 14 | Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. |
| | | | 15 | Sewage microbiology, self-purification in natural waters, sewage treatment. |
| | | | 16 | Drinking water microbiology, sanitary quality of water for aquaculture, bioremediators.Economic significance of aquatic microbes |
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| | | | ***PRACTICAL*** | |
| | | | 1 | Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry. |
| | | | 2 | Determination of size of microorganisms (ocular, stage micrometers). |
| | | | 3 | Tools and techniques in sterilization methods: Filtration, dry heat, moist heat, chemical agents. |
| | | | 4 | Cultivation technique: Media preparation, Isolation - pure culture, subculture. |
| | | | 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, Winogradsky cylinder |
| | | | 9-11 | Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems. |
| | | | 12-13 | Study of bacteria involved in nutrient cycles. |
| | | | 14 | Biofilms detection |
| | | | 15 | water testing for potability- enumeration of coliform |
| | | | 16 | Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method. |

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| **7** | **BSC.112** | **2+1=3** | | **FARMING BASED LIVELIHOOD SYSTEMS** |
| | | | ***THEORY*** | |
| | | | 1 | Status of agriculture in India and different states, |

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| | | | 2 | Income of farmers and rural people in India |
| | | | 3 | Livelihood-Definition, concept and livelihood pattern in urban and rural areas, |
| | | | 4 | Different indicators to study livelihood systems. |
| | | | 5 | Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, |
| | | | 6 | Definition of farming systems and farming based livelihood systems |
| | | | 7 | Prevalent Farming systems in India contributing to livelihood. |
| | | | 8 | Types of traditional farming systems. |
| | | | 9 | Types of modern farming systems. |
| | | | 10 | Components of farming system/ farming-based livelihood systems- Crops and cropping systems, |
| | | | 11 | Components of farming system/ farming-based livelihood systems- Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.) |
| | | | 12 | Components of farming system/ farming-based livelihood systems- Horticultural crops |
| | | | 13 | Components of farming system/ farming-based livelihood systems- Agro--forestry systems, |
| | | | **14** | Components of farming system/ farming-based livelihood systems- Aqua culture Duck/Poultry cum Fish |
| | | | 15 | Components of farming system/ farming-based livelihood systems- Dairy cum Fish |
| | | | 16 | Components of farming system/ farming-based livelihood systems- Piggery cum Fish etc |
| | | | 17 | Small, medium and large enterprises including value chains |
| | | | 18 | Secondary enterprises as livelihood components for farmers |
| | | | 19 | Factors affecting the integration of various enterprises of farming for livelihood. |
| | | | 20 | Feasibility of different farming systems for different agro-climatic zones, |
| | | | 21 | Commercial farming-based livelihood models by NABARD |
| | | | 22 | Commercial farming-based livelihood models by ICAR |
| | | | 23 | Commercial farming-based livelihood models by other organizations across the country, |
| | | | 24 | Case studies on different livelihood enterprises associated with farming |
| | | | 25 | Risk and success factors in farming-based livelihood |

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| | | | | systems |
| | | | 26 | Schemes and programs by Central and State Government organizations involved in promotion of farming-based livelihood opportunities. |
| | | | 27 | Public and Private organizations involved in promotion of farming-based livelihood opportunities. |
| | | | 28 | Role of farming-based livelihood enterprises in 21st Century in view of circular economy |
| | | | 29 | Role of farming-based livelihood enterprises in 21st Century in view of green economy |
| | | | 30 | Role of farming-based livelihood enterprises in 21st Century in view of climate change |
| | | | 31 | Role of farming-based livelihood enterprises in 21st Century in view of digitalization |
| | | | 32 | Role of farming-based livelihood enterprises in 21st Century in view of changing life style. |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Survey of farming systems and agriculturally based livelihood enterprises, |
| | | | 2-4 | Study of components of important farming-based livelihood models/ systems in different agro-climatic zones |
| | | | 4-7 | Study of production and profitability of crop-based, livestock-based, processing-based and integrated farming-based livelihood models, |
| | | | 8 | Field visit of innovative farming system models. |
| | | | 9-11 | Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors |
| | | | 12-13 | Study of agri-enterprises involved in industry and service sectors (Value Chain Models) |
| | | | 14-15 | Learning about the concept of project formulation on farming-based livelihood systems along with cost and profit analysis, |
| | | | 16 | Case study of Start-Ups in agri-sectors. |

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| **8** | **BSC.113** | **1+1=2** | | **COMMUNICATION SKILLS** |
| | | | ***THEORY*** | |
| | | | 1 | Communication Process: The magic of effective communication |
| | | | 2 | Building self-esteem and overcoming fears |
| | | | 3 | Concept, nature and significance of communication process |
| | | | 4 | Meaning, types and models of communication |

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| | | | 5 | Verbal and non-verbal communication |
| | | | 6 | Linguistic and non-linguistic barriers to communication |
| | | | 7 | Reasons behind communication gap/ miscommunication |
| | | | 8 | Basic Communication Skills: Listening, Speaking, Reading |
| | | | 9 | Basic Communication Skills: Writing Skills, Precis writing/ Abstracting/Summarizing; |
| | | | 10 | Style of technical communication Curriculum vitae/resume writing; |
| | | | 11 | Innovative methods to enhance vocabulary, analogy questions. |
| | | | 12 | Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; |
| | | | 13 | Case: subjective case, possessive case; objective case; |
| | | | 14 | Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; |
| | | | 15 | Agreement of verb with the subject: tense, mood, voice; |
| | | | 16 | Writing effective sentences; Basic sentence faults. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Listening and note taking |
| | | | 2-4 | Writing skills: precis writing, summarizing and abstracting |
| | | | 5-6 | Reading and comprehension (written and oral) of general and technical articles |
| | | | 7-8 | Micro-presentations and Impromptu Presentations: Feedback on presentations |
| | | | 9-11 | Stage manners: grooming, body language, voice modulation, speed |
| | | | 12 | Group discussions |
| | | | 13 | Public speaking exercises |
| | | | 14 | Vocabulary building exercises |
| | | | 15 | Interview Techniques |
| | | | 16 | organization of events. |

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| **9** | **BSC.114** | **0+1=1** | | **NSS-I** |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Orientation: history, objectives, principles, symbol, badge; regular programs under NSS |
| | | | 3-4 | organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health |
| | | | 5-6 | NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change. |
| | | | 7-9 | Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration. |
| | | | 10-12 | Indian history and culture, role of youth in nation building, conflict resolution and peacebuilding. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism. |
| | | | 13-16 | Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other communitybased organizations) and society. |

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| **10** | SEC.111 | **0+2=2** | | **AQUARIUM MAKING, DECORATION AND MANAGEMENT** |
| | | | ***PRACTICAL*** | |
| | | | 1 | Identification of Indigenous Ornamental Fish Species |
| | | | 2 | Identification of Exotic Ornamental Fish Species |
| | | | 3 | Identification of Common Ornamental Aquatic Plants |
| | | | 4 | Identification of Common Marine Ornamental Fish Species |
| | | | 5 | Collection and Identification of Local Ornamental Fish from Natural Resources |

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| | | | 6 | Collection and Identification of Local Aquarium Plants from Natural Resources |
| | | | 7 | Steps in the Fabrication of an All-Glass Aquarium |
| | | | 8 | Common Aeration Equipment for Aquariums |
| | | | 9 | Different Types of Filters Used in Aquariums |
| | | | 10 | Different Types of Lighting Equipment and Settings for Aquariums |
| | | | 11 | Decorative Objects for Aquarium Design |
| | | | 12 | Equipment and Kits for Water Quality Monitoring (Heaters, pH Meter, DO Meter, TDS Meter, etc.) |
| | | | 13 | Substrate Selection for Various Aquarium Types |
| | | | 14 | DIY Aquarium Decorations: Design and Creation |
| | | | 15 | Routine Aquarium Maintenance (Cleaning Glass, Filters, and Substrate) |
| | | | 16 | Conditioning and Packing of Ornamental Fish |
| | | | 17 | Procedure for Acclimating New Fish to an Aquarium |
| | | | 18 | Determining Stocking Density for Aquarium Fish |
| | | | 19 | Ensuring Compatibility Among Aquarium Fish |
| | | | 20 | Preparation of Ornamental Fish Feed: Wet and Dry |
| | | | 21 | Live Feed for Aquarium Fish and Larvae |
| | | | 22 | Setting Up a Breeding Tank for Livebearers |
| | | | 23 | Setting Up a Breeding Tank for Barbs, Goldfish, and Tetras |
| | | | 24 | Setting Up a Breeding Tank for Cichlids and Gouramis |
| | | | 25 | Setting Up a Breeding Tank for Fighters |
| | | | 26 | Aqua-scaping Techniques for Aquariums |
| | | | 27 | Identification of Fish Diseases and Preventative Measures |
| | | | 28 | Establishing a Quarantine Facility for Aquarium Units |
| | | | 29 | Study of maturity stages in fish. |
| | | | 30 | Preparation of Bankable Projects for Aquarium-Based Businesses |
| | | | 31-32 | Field Visit to an Aquarium Shop/Public aquarium for Practical Exposure and report writing |

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| **11** | **SEC.112** | **0+2=2** | | **ANALYTICAL TECHNIQUES (TESTING OF WATER, SOIL, FEED ETC.)** |
| | | | ***PRACTICAL*** | |
| | | | 1-3 | Visit to freshwater bodies in nearby area |
| | | | 4-5 | Site selection for water and soil collection |
| | | | 6-7 | Demonstration: demonstration of laboratory glass |

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| | | | | wares and equipment used in water and soil analysis. |
| | | | 8-11 | Chemical preparation for water and soil analysis |
| | | | 12-13 | Collection and preservation of water and soil samples |
| | | | 14 | Analysis of Dissolved oxygen |
| | | | 15 | Analysis of free carbon dioxide |
| | | | 16 | Measurement of temperature and transparency, and turbidity, |
| | | | 17-18 | Determination of pH, electrical conductivity, salinity, and chlorinity, |
| | | | 19 | Measurement of total solids (TDS) |
| | | | 20 | Measurement of total alkalinity |
| | | | 21 | Measurement of Total hardness |
| | | | 22 | Measurement of Nitrate and Nitrite |
| | | | 23-24 | Measurement of Ammonia and phosphorus |
| | | | 25-27 | Study Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity etc |
| | | | 28-30 | Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus etc. |
| | | | 31-32 | Analysis of biochemical composition of feed |

| **I Year** | | | | **II Semester** |
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| **1** | **AQ. 122** | **2+1=3** | | **FISH AND SHELLFISH BREEDING AND HATCHERY MANAGEMENT** |
| | | | ***THEORY*** | |
| | | | 1 | Freshwater and marine fish seed resources. |
| | | | 2 | Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. |
| | | | 3 | Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. |
| | | | 4 | Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages, and disadvantages of bundh breeding. |
| | | | 5 | Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. |
| | | | 6 | Fish pituitary gland – its structure, collection, preservation, and preparation of extract for injection, |

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| | | | | dosages, and methods of injection. |
| | | | 7 | Brood-stock management and transportation of brood fish. |
| | | | 8 | Synthetic hormones used for induced breeding of carps. |
| | | | 9 | Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. |
| | | | 10 | Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. |
| | | | 11 | Use of anesthetics in fish breeding and transport. |
| | | | 12 | Breeding techniques for Indian major carps and exotic carps. |
| | | | 13 | Breeding techniques for Cold water fishes: Mahseer, Trout. |
| | | | 14 | Breeding techniques for Cat fishes. |
| | | | 15 | Breeding techniques for Mullet, Milk fish. |
| | | | 16 | Breeding techniques for Pearl spot, Tilapia. |
| | | | 17 | Breeding techniques for Sea bass, grouper. |
| | | | 18 | Breeding techniques for pacu, cobia, popanos and indigenous species. |
| | | | 19 | Off-season and multiple breeding of carps. |
| | | | 20 | Natural seed resources, site selection and collection methods. |
| | | | 21 | Life cycle of important shellfish (*Penaeus monodon, P. indicus, Macrobrachiumrosenbergii, P. vannamei, Scylla serrata*, lobster, edible, oyster, pearl oyster). |
| | | | 22 | Life cycle of important shellfish (fresh water mussel, holothurians, horseshoe carb, Sepia, Loligo, cray fish etc.). |
| | | | 23 | Sexual maturity and breeding seasons of different species. |
| | | | 24 | Maturation stages of *Macrobrachiumrosenbergii, Penaeus monodon* and *P. vannamei*. |
| | | | 25 | Induced maturation in *Penaeus monodon, P. vannamei*and *P. indicus* by eye stalk ablation. |
| | | | 26 | Reproductive physiology. Reproductive hormones in crustaceans. |
| | | | 27 | Brood stock management of *Penaeus monodon* and *Macrobrachiumrosenbergii*. |
| | | | 28 | Breeding and hatchery management of *P. monodon* and *M. rosenbergii*. |
| | | | 29 | Breeding and hatchery management of crabs. |
| | | | 30 | Breeding and hatchery management of mussels, edible and pearl oysters. |
| | | | 31 | Food and feeding of larval stages of important |

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| | | | | shellfishes. |
| | | | 32 | Health management in hatcheries. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Study of maturity stages in fish. |
| | | | 2 | Collection and preservation of fish pituitary gland and preparation of PG extract, Hypophysation. |
| | | | 3 | Calculation of fecundity. |
| | | | 4 | Brood stock maintenance and selection of brood fishes for injection. |
| | | | 5 | Different fish hatchery systems. |
| | | | 6 | Study of fish eggs and embryonic developmental stages and identification of eggs, spawn, fry and fingerlings of different species. |
| | | | 7 | Preparation and management of fish nursery. |
| | | | 8 | Fish seed and broodstock transportation. Use of anesthetics, disinfectants and antibiotics in fish breeding. |
| | | | 9 | Water quality monitoring in fish hatcheries and nurseries. |
| | | | 10 | Breeding and larval rearing of common finfishes. |
| | | | 11 | Identification of brood stock and maturity stages of important crustaceans and molluscs. |
| | | | 12 | Breeding and larval rearing of *Macrobrachiumrosenbergii, Penaeus monodon,* and *P. vannamei*. |
| | | | 13 | Identification of larval stages of important crustaceans and molluscs. |
| | | | 14 | Demonstration of eyestalk ablation in *Penaeus monodon*. |
| | | | 15 | Collection, packing and transportation of shrimp/prawn seed and brood stock. |
| | | | 16 | Water treatment and management in shrimp and hatcheries. Different chemicals and drugs used in shrimp/ prawn hatchery. |

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| **2** | **FRM.122** | **2+1=3** | | **ANATOMY AND BIOLOGY OF FISH AND SHELLFISH** |
| | | | ***THEORY*** | |
| | | | 1-2 | Study of the external and internal anatomy of important groups of finfish. |
| | | | 3-4 | Study of oral region and associated structures. |
| | | | 5-6 | Digestive system and associated digestive glands. |
| | | | 7 | Food and feeding habits of commercially important fishes. |
| | | | 8 | Qualitative and quantitative methods of analysis of gut contents. |

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| | | | 9-12 | Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. |
| | | | 13-14 | Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. |
| | | | 15-16 | Eggs and larval stages and developmental biology. |
| | | | 17 | Age and growth determination by direct and indirect methods. |
| | | | 18 | Fish migration - type and significance. |
| | | | 19 | Tagging and marking. |
| | | | 20-26 | Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. |
| | | | 27-29 | Food and feeding habits, growth, moulting, length – weight relationship. |
| | | | 30-32 | Reproductive biology, larval stages. |
| | | | ***PRACTICAL*** | |
| | | | 1-3 | Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. |
| | | | 4-5 | Analysis of gut contents. |
| | | | 6 | Estimation of age and growth by direct and indirect methods. |
| | | | 7 | Classification of maturity stages. |
| | | | 8 | Estimation of fecundity. |
| | | | 9-10 | Study of developmental stages. |
| | | | 11 | Tagging and marking. |
| | | | 12-13 | Study of Internal Organs commercially important crustaceans and molluscs. |
| | | | 14 | Study of Digestive, respiratory, circulatory, nervous, and reproductive systems. |
| | | | 15 | Length - weight relationship and condition. |
| | | | 16 | Reproductive biology: maturity stages, spawning periodicity, fecundity, and larval stages. |

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| **3** | **FRM.123** | **2+1=3** | | **PHYSIOLOGY OF FISH AND SHELLFISH** |
| | | | THEORY | |
| | | | 1 - 2 | Water as a biological medium. |
| | | | 3 - 5 | Gas exchange; |
| | | | 6 - 8 | Circulation |
| | | | 9 - 11 | Excretion |

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| | | | 12 -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 | |
| | | | 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 |

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| **4** | **AEM.123** | **1+1=2** | | **LIMNOLOGY** |
| | | | ***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 diversity. Famous lakes of the world and India |
| | | | 5-6 | Nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations: influence of physical and chemical conditions on living organisms in inland waters. |
| | | | 7 | Classification of lakes, thermal stratification in lakes |
| | | | 8-9 | 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; |
| | | | 9 | Aquatic plants: characteristics, classification, zonation, &limnological role. |
| | | | 10-11 | Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, |

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| | | | | profundal bottom fauna |
| | | | 12-13 | 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; |
| | | | 14 | successional phenomena; indices of productivity of lakes; artificial enrichment |
| | | | 15-16 | Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Field visit to lotic and lentic water bodies |
| | | | 2-5 | Determination of physical & chemical characteristics of lentic and lotic environment |
| | | | 6-8 | Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton |
| | | | 9-11 | Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. |
| | | | 11-13 | Collection and identification of aquatic plants from different fresh water bodies. |
| | | | 14-15 | Collection and identification of nekton/aquatic insects from freshwater bodies |
| | | | 16 | Collection and identification of benthos from lakes and ponds, streams, and canals. |

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| **5** | **BSC.125** | **2+1=3** | | **ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT** |
| | | | ***THEORY*** | |
| | | | 1-2 | Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. |
| | | | 3 | Concept, need and importance of entrepreneurial development. |
| | | | 4 | Evolution of entrepreneurship & objectives of entrepreneurial activities |
| | | | 5-6 | Types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. |

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| | | | 7-9 | Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product/service – starting a project; factors influencing sensing the opportunities. |
| | | | 10-12 | Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. |
| | | | 13 | Steps involved in functioning of an enterprise. |
| | | | 14-16 | Selection of the product/services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing knowhow, packaging and distribution. |
| | | | 17-19 | Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. |
| | | | 20-22 | Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. |
| | | | 23-24 | Production management – raw material costing, inventory control. |
| | | | 25-26 | Personal management – manpower planning, labour turn over, wages/salaries. |
| | | | 27-29 | Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long-term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. |
| | | | 30-31 | Marketing management- market, types, marketing assistance, market strategies.Marketing management-market, types, marketing assistance, market strategies. |
| | | | 32 | Crisis management- raw material, production, leadership, market, finance, natural etc. |
| | | | ***PRACTICAL*** | |
| | | | 1-4 | Visit to small scale industries/agro-industries |
| | | | 5-8 | Interaction with successful entrepreneurs/ agric entrepreneurs. |
| | | | 9-12 | Visit to financial institutions and support agencies. |
| | | | 13-16 | Preparation of project proposals for funding by different agencies. |

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| **6** | **BSC.126** | **2+1=3** | | **ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT** |
| | | | ***THEORY*** | |
| | | | 1-3 | Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. |
| | | | 4-6 | Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. |
| | | | 7-8 | Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. |
| | | | 9 | Biodiversity and its conservation: Introduction, definition, types. |
| | | | 10-11 | Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity. |
| | | | 12-14 | Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (h) light pollution. |
| | | | 15-17 | Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. |
| | | | 18-19 | Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. |
| | | | 20-22 | Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. |
| | | | 23-24 | Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. |
| | | | 25-26 | Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. |
| | | | 27-28 | Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, |

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| | | | | earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. |
| | | | 29-30 | Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. |
| | | | 31 | International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. |
| | | | 32 | Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. |
| | | | 2 | Energy: Biogas production from organic wastes. |
| | | | 3 | Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. |
| | | | 4 | Floral and faunal diversity assessment in polluted and un polluted system. |
| | | | 5-6 | Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. |
| | | | 7-8 | Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. |
| | | | 9 | Estimation of Acidity, Alkalinity. |
| | | | 10-11 | Estimation of water hardness. Estimation of DO and BOD in water samples. |
| | | | 12-13 | Estimation of COD in water samples. Enumeration of E. coli in water sample. |
| | | | 14 | Assessment of Suspended Particulate Matter (SPM). |
| | | | 15 | Study of simple ecosystem – Visit to pond/river/hills. |
| | | | 16 | Visit to areas affected by natural disaster. |

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| **7** | **BSC.127** | **1+1=2** | | **PERSONALITY DEVELOPMENT** |
| | | | ***THEORY*** | |
| | | | 1 | Personality Definition, Nature of personality, theories of personality and its types. |
| | | | 2 | The humanistic approach - Maslow's self-actualization theory |
| | | | 3 | Shaping of personality, determinants of personality |
| | | | 4 | Myers-Briggs Typology Indicator, Locus of control and |

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| | | | | performance, |
| | | | 5 | Type A and Type B Behaviours, personality and Organizational Behaviour. |
| | | | 6 | Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior |
| | | | 7 | Perception and attributes and factors affecting perception, |
| | | | 8 | Attribution theory and case studies on Perception and Attribution. |
| | | | 9 | Learning: Meaning and definition, theories and principles of learning. |
| | | | 10 | Learning and organizational behavior, Learning and training, learning feedback. |
| | | | 11 | Attitude and values |
| | | | 12 | Intelligence- types of Intelligence, theories of intelligence |
| | | | 13 | Measurements of intelligence, factors influencing intelligence |
| | | | 14 | Intelligence and Organizational behavior, emotional intelligence |
| | | | 15 | Motivation- theories and principles |
| | | | 16 | Teamwork and group dynamics |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | MBTI personality analysis |
| | | | 3 | Learning Styles and Strategies |
| | | | 4 | Motivational needs |
| | | | 5 | Firo-B, |
| | | | 6 | Interpersonal Communication |
| | | | 7-8 | Teamwork and team building |
| | | | 9 | Group Dynamics |
| | | | 10-11 | Win-win game |
| | | | 12 | Conflict Management |
| | | | 13 | Leadership styles |
| | | | 14-15 | Case studies on Personality |
| | | | 16 | Case studies on Organizational Behavior |

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| **8** | **NSS-II** | **0+1=1** | | **NSS-II** |
| | | | ***PRACTICAL*** | |
| | | | 1 | Importance and role of youth leadership |
| | | | 2 | Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, |

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| | | | | Life competencies |
| | | | 3 | Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs |
| | | | 4 | Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations |
| | | | 5 | Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. |
| | | | 6 | Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. |
| | | | 7 | Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method. |

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| **9** | **SEC.123** | **0+2=2** | | **FISH BREEDING AND HATCHERY OPERATION** |
| | | | ***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 management |
| | | | 6 | Fish seed and brood stock transportation. |
| | | | 7 | Use of anesthetics, disinfectants and antibiotics in fish breeding. |
| | | | 8 | Designing and Layout of a typical catfish hatchery |
| | | | 9 | Designing and Layout of a typical cold water fish hatchery |
| | | | 10 | Designing and Layout of a typical marine or brackishwater fish hatchery |
| | | | 11-17 | Designing and Layout of carp hatchery |
| | | | | A) Site selection |
| | | | | B) Estimation of brood fish requirement |
| | | | | C) Calculation of area required for brood fish rearing tank |
| | | | | D) Calculation of the dimension of the spawning pool |
| | | | | E) Calculation of the dimension of the incubation |

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| | | | | pool |
| | | | | F) Calculation of area required for nursery tank |
| | | | 18 | Hatchery setup and pre-breeding management |
| | | | 19 | Selection of brood fish |
| | | | 20 | Sexual dimorphism in commercially important fishes |
| | | | 21 | Methods of hormonal injections |
| | | | 22 | Operation of the spawning pool |
| | | | 23 | Operation of the incubation pool |
| | | | 24 | Study of embryonic developmental stages of fishes |
| | | | 25 | Estimation of the number of eggs present incubation pool, fertilization rate, hatching rate, and spawn recovery |
| | | | 26 | Method of fish striping (Wet striping and dry striping) |
| | | | 27 | Water quality monitoring in fish hatcheries |
| | | | 28 | Identification of larval stages of different species |
| | | | 29 | Visit to fish hatchery |
| | | | 30-32 | Preparation of a bankable project for the establishment of the fish hatchery |

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| **10** | **SEC.124** | **0+2=2** | | **FISH HANDLING, PRESERVATION AND VALUE ADDITION** |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | **To study the organoleptic characteristics of seawater and freshwater fish and shellfish.** |
| | | | | Importance of sensory evaluation (visual, aroma and odor, taste, appearance/ texture). |
| | | | | Structure of the Nine-Point Hedonic Scale. |
| | | | | Organoleptic characteristics of both seawater and freshwater fish and shellfish. |
| | | | 3-5 | **Knowledge of Basic Processing Techniques/ Understanding Basic Processing Techniques** |
| | | | | Cleaning and Gutting: Learn how to properly clean and gut fish to maintain hygiene and quality. |
| | | | | Scaling, Skinning and peeling: Practice removing scales and skin of finishes and peeling and deveining of shrimps or prawns |
| | | | | Filleting: Learn how to effectively fillet various species and reduce waste. |
| | | | 6-9 | **Fish Preservation Methods** |
| | | | | Freezing: Understand most favorable freezing temperatures and methods to maintain freshness of fish and shellfish. |
| | | | | Curing (Salting, Smoking): Learn how to cure fish with salt or smoke to extend shelf life while |

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| | | | | enhancing flavor. |
| | | | | Ø Drying and dehydration: Explore sun-drying, air-drying techniques for different/local avaible fish species. |
| | | | 10-11 | **Preparation of mince meat** |
| | | | | Traditional method |
| | | | | Using meat mincer/bone separator |
| | | | | Surimi-based mincing (washing) |
| | | | 12-14 | **Value added fish products**: Techniques to create value-added fish products |
| | | | | Fish mince and mince-based products: Fish fingers, fish cutlets, fish burger, fish sausages, fish chakali, shev etc |
| | | | | Restaurant oriented fish products: Fish momos, fish pizza, fish briyani, fish tikka, fish wraps/rolls, and fish Samosa etc. |
| | | | 15-16 | **Quality Control and Safety Standards** |
| | | | | Introduction to food Safety in Fish Processing: Implementation of good manufacturing practices (GMP) and hygiene standards. |
| | | | | Fundamentals of Hazard Analysis and Critical Control Points (HACCP) |
| | | | | Microbiological and Chemical Testing: Techniques/methods to examine contaminants, pathogens, and spoilage in fishery products. |

| **Post Semester-II Exit option forward of UG-Certificate)** | | | |
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| **INT.121** | **Internship***** | **10 (0+10)** | **10 (0+10)** |

| **II Year** | | | | **III Semester** |
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| **1** | **AQ. 213** | **2+1=3** | | **COASTAL AQUACULTURE AND MARICULTURE** |
| | | | ***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, Vennamei shrimp, mud crab. |
| | | | 5 | Traits of important cultivable fish and shellfish: |

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| | | | | 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 | Traditional (bheries, Gheries) shore based aquaculture systems in India |
| | | | 9 | Traditional shore based aquaculture systems in India: Pokali fields in kerala |
| | | | 10 | Traditional (gaznisand khazans) shore based aquaculture systems in India |
| | | | 11 | Site selection for coastal aquaculture and mariculture |
| | | | 12 | Farm designing for coastal aquaculture |
| | | | 13 | 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 | Culture of oyster |
| | | | 23 | Culture of sea weed |
| | | | 24 | Methods of aquaculture - cages |
| | | | 25 | Methods of aquaculture - Rafts, racks, poles and ropes |
| | | | 26 | Water and soil quality management: Important water quality parameters |
| | | | 27 | Water and soil quality management: Management |

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| | | | | including reclamation of acid sulphate soil |
| | | | 28 | Estimation of growth, survival and pond productivity |
| | | | 29 | Modern practices of shrimp farming in India |
| | | | 30 | Sea ranching. |
| | | | 31 | Pearl culture |
| | | | 32 | Economic analysis of modern shrimp farming |
| | | | ***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. |

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| **2** | **FRM.214** | **1+1=2** | | **INLAND FISHERIES** |
| | | | ***THEORY*** | |
| | | | 1 | Freshwater fishery regions of the world and their major fish species composition. |
| | | | 2 | Global inland fish production data. |
| | | | 3 | Capture fishery resources of India. |
| | | | 4 | Potential of inland water bodies with reference to the respective state. |
| | | | 5 | Problems in the estimation of inland fish catch data. |
| | | | 6 | Fishing crafts and gears. |
| | | | 7-10 | Major riverine and estuarine systems of India. |
| | | | 11-13 | Major brackish water lakes and their fisheries. |
| | | | 14 | Fisheries of major reservoirs / natural lakes of India. |

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| | | | 15 | Flood-plain capture fishery- present status of their exploitation and future prospects. |
| | | | 16 | Cold water fisheries of India. |
| | | | ***PRACTICAL*** | |
| | | | 1-4 | Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. |
| | | | 5-8 | Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. |
| | | | 9-10 | Maintenance of records on catch data. |
| | | | 11-16 | Visit to Dept. of fisheries, lakes and reservoirs, floodplain wetlands, coldwater bodies, net making yards. |

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| **1** | **FE.211** | **1+1=2** | | **FISHING CRAFT TECHNOLOGY** |
| | | | ***THEORY*** | |
| | | | 1 | Introduction: History and development of fishing crafts. Traditional fishing crafts of India. |
| | | | 2 | Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation |
| | | | 3 | History and development of mechanization of fishing crafts. |
| | | | 4 | Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes |
| | | | 5 | Calculation of the 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). Stability of fishing vessels-longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral |
| | | | 7 | Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). |
| | | | 8 | Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages |
| | | | 9 | Deck fitting. |
| | | | 10 | Maintenance of fishing vessels. Fouling and boring organisms; |
| | | | 11 | Seasoning and preservation of wood. |

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| | | | 12 | Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. |
| | | | 13 | Constructional details of Steel, FRP, boats. |
| | | | 15 | Constructional details of Ferro Cement and Aluminum boats. |
| | | | 16 | Introduction of Outboard and inboard engines. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Studies on traditional fishing crafts; |
| | | | 2 | Studies on traditional fishing crafts; |
| | | | 3 | Introduction to drawing and drawing instruments; |
| | | | 4 | Lettering, Geometrical construction, Curves. Projections |
| | | | 5 | Projection of points, planes and Projection of solids |
| | | | 6 | Lines plan drawing |
| | | | 7 | Drawing of back bone assembly |
| | | | 8 | U and V bottom hull of wooden boat. |
| | | | 9 | General view of boat. |
| | | | 10 | Drawing of sheer plan. |
| | | | 11 | Drawing of body plan |
| | | | 12 | Drawing of half breadth plan. |
| | | | 13 | Types of marine engines and their installation of engines. |
| | | | 14 | Types of marine engines and their installation of engines. |
| | | | 15 | Visit to boat building yard. |
| | | | 16 | Visit to boat dry dock. |

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| **4** | **FE.211** | **2+1=3** | | **FUNDAMENTALS OF BIOCHEMISTRY AND FOOD CHEMISTRY** |
| | | | ***THEORY*** | |
| | | | 1 | A brief introduction to developments in biochemistry and its transformation to molecular biology. |
| | | | 2 | Cell structure, water and major molecules of life. |
| | | | 3 | Composition of food and nutritional value. |
| | | | 4 | Moisture in foods. |
| | | | 5-6 | Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydrates: Structure, classification and functions of carbohydrate. |
| | | | 7 | Isomerism and mutarotation. |
| | | | 8 | Metabolism of carbohydrates: Glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. |

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| | | | 9 | Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic. |
| | | | 10 | Lipids: Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. |
| | | | 11 | Metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Lipid autooxidation. |
| | | | 12 | Significance of Omega-3 and Omega-6 fatty acids. |
| | | | 13 | Proteins: Classification, structure, function and properties of proteins. |
| | | | 14 | Essential and nonessential amino acids. |
| | | | 15 | Biuret reaction and xanthoproteic reaction of protein detection. |
| | | | 16 | Metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. |
| | | | 17 | Deamination reactions and nitrogen excretion with special reference to fish. |
| | | | 18 | Fish muscle proteins, chemical changes in muscle during contraction. |
| | | | 19-20 | Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing. |
| | | | 21 | Texturized proteins. Enzymes: Nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. |
| | | | 22 | Steroid and peptide hormones: Chemistry and function. |
| | | | 23 | Vitamins and Minerals: Classification and functions. Structure and functions of fat and water-soluble vitamins. |
| | | | 24 | Minerals: Classification and functions minerals. Nucleic acids: Structure and function. Importance of genetic code. |
| | | | 25 | Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. |
| | | | 26-28 | Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. |
| | | | 29 | Assessment of quality of food by instrumental and chemical methods. |

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| | | | 30 | Nutritive value of foods. Energy value and energy requirements and their estimation. |
| | | | 31 | Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. |
| | | | 32 | Role of fibre in human nutrition. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Preparation of normal solution of acid and base, buffers and reagents. |
| | | | 2 | Estimation of moisture in fish sample |
| | | | 3 | Estimation of crude protein in fish sample |
| | | | 4 | Estimation of fat in fish sample |
| | | | 5 | Estimation of ash (including acid soluble) in fish sample. |
| | | | 6 | Estimation of carbohydrates in foods. |
| | | | 7 | Determination of energy value of fish. |
| | | | 8 | Estimation of glucose and salt content in foods. |
| | | | 9 | Colorimetric method of estimation of proteins and carbohydrates. |
| | | | 10-13 | Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. |
| | | | 14 | Estimation of fibre in foods. |
| | | | 15 | Determination of specific gravity of oil. |
| | | | 16 | Determination of saponification value, iodine value and free fatty acid value. |

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| **5** | **FEES.211** | **1+1=2** | | **FISHERIES EXTENSION** |
| | | | ***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, factors influencing their selection and use |
| | | | 5 | characteristics of technology |
| | | | 6 | 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, |

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| | | | 10 | adopter categories and barriers in the 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*** | |
| | | | 1 | Collection of socio-economic data from fishing villages; |
| | | | 2 | Study of social issues/problems through participatory and rapid rural appraisal techniques, |
| | | | 3 | Study of social issues/problems through stake holders analysis |
| | | | 4 | Study of social issues/problems through needs assessment |
| | | | 5 | Assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis; |
| | | | 6 | Case studies on social/gender issues and social conflicts in fisheries. |
| | | | 7 | Case studies on extension programs and Success stories. |
| | | | 8 | Practical exercise on conducting fish farmers meet. |
| | | | 9 | Case study on fish seed hatchery/fish farm |
| | | | 10 | Study of social issues/problems through needs assessment |
| | | | 11 | Study of social issues/problems through needs assessment |
| | | | 12 | Case study on fishermen co-operative society |
| | | | 13 | Case study on fishermen co-operative society |
| | | | 14 | Formulation of fisheries extension programme |
| | | | 15 | Formulation of fisheries extension programme |
| | | | 16 | Formulation of fisheries extension programme |

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| **6** | **BSC.219** | **2+1=3** | | **AGRICULTURE MARKETING AND TRADE** |
| | | | ***THEORY*** | |
| | | | 1 | Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, |

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| | | | 2 | Market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; |
| | | | 3 | Demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, |
| | | | 4 | Producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities |
| | | | 5 | Pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; |
| | | | 6 | Market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits |
| | | | 7 | Marketing process and functions: Marketing process concentration, dispersion and equalization; |
| | | | 8 | Exchange functions – buying and selling; |
| | | | 9 | Physical functions – storage, transport and processing; |
| | | | 10 | Facilitating functions – packaging, branding, grading, quality control and labeling (Agmark) |
| | | | 11 | Market functionaries and marketing channels: |
| | | | 12 | Types and importance of agencies involved in agricultural marketing |
| | | | 13 | Meaning and definition of marketing channel; Number of channel levels; marketing channels for different farm products |
| | | | 14 | Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; |
| | | | 15 | Marketing efficiency; Marketing costs, margins and price spread |
| | | | 16 | factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs |
| | | | 17-20 | Role of Government in agricultural Marketing Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; |
| | | | 21 | Cooperative marketing in India; |
| | | | 22 | Risk in marketing: Types of risk in marketing; |
| | | | 23 | Speculation and hedging; an overview of futures trading; |
| | | | 24 | Agricultural prices and policy: Meaning and functions of price |
| | | | 25 | administered prices; need for innovations in |

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| | | | | agricultural price policy; |
| | | | 26 | Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. |
| | | | 27 | Present status and prospects of international trade in agri-commodities; |
| | | | 28 | WTO |
| | | | 29 | Agreement on Agriculture (AoA) and its implications on Indian agriculture |
| | | | 30 | IPR |
| | | | 31 | Role of government in agricultural marketing. |
| | | | 32 | Role of APMC and its relevance in the present-day context |
| | | | ***PRACTICAL*** | |
| | | | 1-3 | Plotting and study of demand and supply curves and calculation of elasticities |
| | | | 4 | Study of relationship between market arrivals and prices of some selected commodities |
| | | | 5 | Computation of marketable and marketed surplus of important commodities; |
| | | | 6-7 | Study of price behaviour over time for some selected commodities; Construction of index numbers |
| | | | 8-9 | Visit to a local market to study various marketing functions performed by different agencies |
| | | | 10 | Identification of marketing channels for selected commodity |
| | | | 11-13 | Collection of data regarding marketing costs, margins and price spread and presentation of report in the class |
| | | | 14-15 | Visit to market institutions – NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; |
| | | | 16 | Application of principles of comparative advantage of international trade |

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| **7** | **BSC.211** | **2+1=3** | | **AGRICULTURAL INFORMATICS AND ARTIFICIAL INTELLIGENCE** |
| | | | ***THEORY*** | |
| | | | 1 | Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory |
| | | | 2-4 | Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions |
| | | | 5-6 | Database, concepts and types, creating database, Uses of DBMS in Agriculture |

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| | | | 7 | Internet and World Wide Web (WWW): Concepts and components |
| | | | 8-9 | Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/ C++, etc. concepts and standard input/output operations |
| | | | 10-11 | e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture |
| | | | 12-15 | Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation |
| | | | 16-18 | IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in agriculture for farm advice: Market price, postharvest management etc. |
| | | | 19 | Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information |
| | | | 20-22 | Decision support systems: Concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting farm decisions |
| | | | 23-25 | Preparation of contingent crop-planning and crop calendars using IT tools, Digital India and schemes to promote digitalization of agriculture in India |
| | | | 25 | Introduction to artificial intelligence, background and applications, |
| | | | 26-28 | Turing test, Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data |
| | | | 29-31 | Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications |
| | | | 32 | Concepts of smart agriculture, use of AI in food and nutrition science etc. |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Study of computer components, accessories, practice of important DOS Commands. |
| | | | 3-4 | Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. |
| | | | 5 | Use of MS-WORD and MS Power-point for creating, |

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| | | | | editing and presenting a scientific document |
| | | | 6 | MS-EXCEL - Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, Handling macros. |
| | | | 7 | MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system |
| | | | 8 | Introduction to World Wide Web (WWW) and its components |
| | | | 9-10 | Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++ |
| | | | 11-13 | Hands-on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools |
| | | | 14 | Use of smart phones and other devices in agro-advisory and dissemination of market information |
| | | | 15-16 | Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA). |

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| **8** | **BSC.212** | **0+2=2** | | PHYSICAL EDUCATION, FIRST AID, YOGA PRACTICE AND MEDITATION |
| | | | ***PRACTICAL*** | |
| | | | 1 | Physical education; Training and Coaching - Meaning and Concept; |
| | | | 2-4 | Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; |
| | | | 5-6 | Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and |
| | | | 7 | Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; |
| | | | 8-9 | Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; |
| | | | 10-11 | Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture. |
| | | | 12-13 | Yoga; History of Yog, Types of Yog, Introduction to Yog, |
| | | | 14-18 | Asanas (Definition and Importance) Padmasan,san, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, |

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| | | | | Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan |
| | | | 19 | Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari |
| | | | 20-22 | Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh |
| | | | 23-25 | Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra |
| | | | 25 | Role of yoga in sports |
| | | | 26-30 | Teaching of Asanas – demonstration, practice, correction and practice. |
| | | | 31 | History of sports and ancient games, Governance of sports in India; Important national sporting events; |
| | | | 32 | Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics |

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| **9** | **SEC.215** | **0+2=2** | | **FISH MARKET SURVEY AND VALUE CHAIN ANALYSIS** |
| | | | ***PRACTICAL*** | |
| | | | 1-4 | **Market Observation and Data Collection**<br>• Visit to various fish markets, record prices of various fish species, their quality, and any seasonal trends.<br>• Observe the volume of fish sold, the types of fish, and the main buyers (retailers, wholesalers, or direct consumers).<br>• Conduct informal interviews with buyers and sellers to learn about demand fluctuations, preferred fish species, and pricing decisions. |
| | | | 5-8 | **Supply Chain Mapping**<br>• Interview the key stakeholders like fishermen, wholesalers, retailers, and consumers.<br>• Identify and document each step in the fish supply chain: harvesting, processing, transportation, distribution, and retailing.<br>• Analyse the roles, relationships, and power dynamics between stakeholders.<br>• Look at logistics, cold storage facilities, and |

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| | | | | transportation methods used to keep fish fresh and safe. |
| | | | 9-13 | **Price Analysis**<br>• Track fish prices at different stages: from fishermen (or fish farms) to wholesalers to retailers.<br>• Collect data on seasonal price variations, geographic price differences, and the impact of supply and demand.<br>• Analyse the cost structures of fish-related businesses to identify profit margins and costs at each stage of the chain. |
| | | | 14-17 | **Stakeholder Interviews and Focus Groups**<br>• Conduct interviews or focus group discussions with fishermen, market vendors, retailers, and consumers.<br>• Ask about their challenges, needs, pricing strategies, and how they see changes in the fish market (e.g., environmental impacts, fish scarcity, or government policies).<br>• Gather insights into the quality and freshness of fish, consumer preferences, and purchasing habits. |
| | | | 18-21 | **Fish Quality Assessment**<br>• Inspect fish for signs of freshness: clear eyes, shiny scales, firm flesh, and the smell.<br>• Record how quality varies between different types of fish, seasons, and suppliers.<br>• Interview consumers on how they assess the quality of fish before buying, and what factors influence their choice (appearance, price, freshness).<br>• Compare the quality of fish at different market points (auction, wholesalers, and retail). |
| | | | 22-23 | **Fish Waste and Loss Analysis**<br>• Quantify fish waste at different stages, including unsold fish, damaged fish, and spoilage.<br>• Interview stakeholders about the causes of waste (e.g., improper storage, handling, or transportation).<br>• Assess how much waste is recycled or disposed of and the environmental impacts of this waste. |
| | | | 24-25 | **Economic Impact Study**<br>• Conduct surveys with local fish market participants to understand their income sources, employment generation, and contribution to the |

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| | | | | local economy.<br>• Track spending patterns and local investments made by fish market stakeholders (e.g., the purchase of equipment, hiring labour, etc.).<br>• Identify the flow of revenue and economic multiplier effects on related sectors such as transportation, packaging, and retail. |
| | | | 26-27 | **Consumer Behaviour Survey**<br>• Distribute questionnaires to consumers in the fish market and gather data on factors influencing their choice of fish (e.g., price, quality, type of fish, ethical sourcing, or sustainability concerns).<br>• Explore purchasing frequency, spending patterns, and potential willingness to pay for premium fishes.<br>• Examine awareness of health benefits. |
| | | | 28-29 | **Regulatory and Policy Analysis**<br>• Review local, regional, and national regulations governing fish trade, fishing quotas, and sustainability practices.<br>• Interview policymakers, fish traders, and fishery management authorities about the impact of policies on the fish market.<br>• Assess how regulations are enforced, and the level of compliance within the industry. |
| | | | 30-32 | **Sustainability Assessment**<br>• Investigate if and how fish sellers and buyers are incorporating sustainability into their practices (e.g., buying from sustainable fisheries or adopting eco-friendly packaging).<br>• Interview stakeholders about practices such as catch limits, fishing gear, etc.<br>• Assess consumer demand for sustainably sourced or certified fish. |

| **II Year** | | | | **IV Semester** |
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| **1** | **AQ. 224** | **2+1=3** | | **FISH NUTRITION AND FEED TECHNOLOGY** |
| | | | ***THEORY*** | |
| | | | 1-2 | Fundamentals of fish nutrition and growth in fish. |
| | | | 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). |

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| | | | 6 | Principal nutrients and nutritional requirements of cultivable fish and shellfish (Vitamin requirement). |
| | | | 7-8 | Nutritional energetics: definition and forms of energy partitioning. |
| | | | 9-10 | Methods of feed formulation and manufacturing. |
| | | | 11 | Forms of feeds: wet feeds, moist feeds,<br>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. |
| | | | 14 | Feed additives: 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. |
| | | | 21 | Feed evaluation - protein efficiency ratio, net protein utilization and biological value. |
| | | | 22 | Feeding devices. |
| | | | 23 | Feeding methods-Hand feeding, bag feeding, Automatic feeders. |
| | | | 24 | Different feeding strategies. |
| | | | 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 | Non-conventional feed ingredients. |
| | | | 29 | Antinutritional factors in feed ingredients. |
| | | | 30 | Feed digestion: Digestive fluid and enzymes. |
| | | | 31 | Digestibility and factors affecting digestibility. |
| | | | 32 | Nutritional deficiency diseases. |
| | | | ***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 |

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| | | | | 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.(Weighing, Grinding, mixing, pelleting and drying). |
| | | | 8 | Calculation of feeding rate and feeding frequency. |
| | | | 9 | Formulation and preparation of moist feed by using locally available ingredients. |
| | | | 10 | Determination of sinking rate and stability of feeds. |
| | | | 11 | Determination of storage effect on feed quality -Protein associated changes |
| | | | 12 | Determination of storage effect on feed quality – Fat associated changes. |
| | | | 13 | Estimation of the digestible energy content of the feed. |
| | | | 14 | Estimation of the gross energy content of feed. |
| | | | 15 | Equipments and machineries used in feed production. |
| | | | 16 | Visit to commercial feed plant. |

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| **2** | **AQ. 225** | **1+1=2** | | **BREEDING AND CULTURE OF ORNAMENTAL FISH** |
| | | | ***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 |

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| | | | 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*** | |
| | | | 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 |

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| **3** | **AQ. 226** | **1+1=2** | | **LIVE FOOD ORGANISMS FOR FISH AND SHELLFISH** |
| | | | ***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 |

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| | | | 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*** | |
| | | | 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 |

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| | | | 15 | Hatching of artemia cyst |
| | | | 16 | Evaluation of live food organism |

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| **4** | **FRM.225** | **1+1=2** | | **MARINE FISHERIES** |
| | | | ***THEORY*** | |
| | | | 1 | Classification and definition of fishery zones and fishery resources of world. |
| | | | 2-3 | Overview of marine fisheries resources of the world and India. |
| | | | 4-6 | Major exploited marine fisheries of India, their developmental history and present status. |
| | | | 7-9 | Important pelagic, demersal fish, shellfish and seaweed resources of India. |
| | | | 10-12 | Traditional, motorized and mechanized fisheries according to major gears. |
| | | | 13-14 | Potential marine fishery resources of India's EEZ. |
| | | | 15 | GIS and Remote sensing in marine capture fishery. |
| | | | 16 | Conservation and management of marine fisheries resources in India. |
| | | | ***PRACTICAL*** | |
| | | | 1-8 | Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. |
| | | | 9-12 | 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. |

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| **5** | **AAHM.222** | **2+1=3** | | **FISH AND SHELLFISH DISEASES AND TREATMENT** |
| | | | ***THEORY*** | |
| | | | 1-3 | General characteristics, life cycle, diagnosis of pathogens. |
| | | | 4-7 | Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. |
| | | | 8 | OIE listed diseases. Disease surveillance and reporting. |
| | | | 9 | Quarantine and health certification in aquaculture. |
| | | | 10-14 | Health management strategies in Aquaculture: Bioremediators, Biocontrol agents, Probiotics, Immunomodulators, Concepts of vaccination. |
| | | | 15 | Shrimp toilet. Management measures for the host. |
| | | | 16-18 | Specific pathogen-free (SPF), Specific pathogen-resistant (SPR) and Specific pathogen-tolerant (SPT). |
| | | | 19-22 | Developing management practices and biosecurity |

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| | | | | principles: Health maintenance, Better management practices (BMP), Good aquaculture practices (GAP) |
| | | | 23-24 | Hazard analysis and Critical control point (HACCP) and Biosecurity principles in aquaculture. |
| | | | 25 | Disease control through environmental management |
| | | | 25-26 | Importance of Biofilm and Bio-floc |
| | | | 27 | Periphyton in aquatic health management. |
| | | | 28 | Zoonotic diseases |
| | | | 29-32 | Principles of disease diagnosis: Conventional, molecular and antibody-based diagnostic methods. Rapid diagnostic methods. |
| | | | ***PRACTICAL*** | |
| | | | 1 | General procedure for disease diagnosis |
| | | | 2 | Methods of fish and shell-fish sampling for disease diagnosis |
| | | | 3 | Taxonomy, lifecycle and identification of fish and shell-fish parasites. |
| | | | 4 | Sampling, preparation of media and culture of pathogenic bacteria. |
| | | | 5 | Techniques for bacterial classification |
| | | | 6-11 | Techniques in disease diagnosis: Microbiological, haematological, histopathological, immunological, molecular techniques and biochemical tests. |
| | | | 12-13 | Agglutination test and Challenge tests; Purification of virus. |
| | | | 14 | Stress-related study of fish and shell-fish. |
| | | | 15-16 | Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shell-fish. |

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| **6** | **FE. 222** | **2+1=3** | | **FISHING AND GEAR TECHNOLOGY** |
| | | | ***THEORY*** | |
| | | | 1 | Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears Principle, Subsidiary and Auxiliary gears. |
| | | | 2 | Classification of fishing gears and methods: FAO classification of fishing gear, methods of the world. |
| | | | 3 | Classification of fishing gears and methods: 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; Different types of fibres- |

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| | | | | continuous fibre; monofilament, staple and split fibers and production of single yarns. |
| | | | 6 | Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test. |
| | | | 7 | Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order. |
| | | | 8 | 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, and tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption and shrinkage, sinking velocity, weather resistance, melting point and visibility. Chemical and Biological properties. |
| | | | 13 | Floats and 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. |
| | | | 16 | Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear. |
| | | | 17 | Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board. |
| | | | 18 | Structure of various commercial fishing gears. |
| | | | 19 | Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gear arrangements. |
| | | | 20 | Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and |

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| | | | | angle of tilt. |
| | | | 21 | Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw,. |
| | | | 22 | Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid-water trawling. |
| | | | 23 | Constructional details of single-boat purse seine; two-boat purse seine and method of operation. |
| | | | 24 | Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, |
| | | | 25 | Operation of gillnet: set gillnetting; drift gillnetting; bottom, mid-water and pelagic gillnetting |
| | | | 26 | Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole and line and trolling line. |
| | | | 27 | Operation of long line: set and drift |
| | | | 28 | Long lining: bottom, mid-water and pelagic long lining; jigging. |
| | | | 29 | Operation of beach seine, boat seine and traps. |
| | | | 30 | Selectivity in fishing gear and by catch-reducing devices. |
| | | | 31 | Deck equipment – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. |
| | | | 32 | Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Study of net making tools. |
| | | | 2 | Knots and hitches used in net making. |
| | | | 3 | Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. |
| | | | 4 | Shaping of webbing: baiting, creasing and reducing mesh size step by step. |
| | | | 5 | Tailoring method: T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination. |
| | | | 6 | Joining of net pieces. |
| | | | 7 | Net mounting – hanging coefficient, hung depth and their calculation. |
| | | | 8 | Selvedging. |
| | | | 9 | Methods of net mounting: reeving, stapling and norselling. |
| | | | 10 | Mending and net shooter techniques. |
| | | | 11 | Survey of fishing gears; Trawl; gillnet fishing gears. |
| | | | 12 | Survey of fishing gears; long line fishing gears. |

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| | | | 13 | Survey of fishing gears; purse seine fishing gears. |
| | | | 14 | Rigging of trawl, purse seine, gillnet and hook and line. |
| | | | 15 | Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. |
| | | | 16 | Commercial fishing techniques: Cast net fishing and trap fishing. |

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| **7** | **FPT.222** | **1+1=2** | | **POST-HARVEST HANDLING AND PRESERVATION** |
| | | | ***THEORY*** | |
| | | | 1 | Structure of fish myosystems, Postmortem changes - Structural and chemical. |
| | | | 2 | Fish as raw material for processing: Body structure, physical properties, shape, specific weight, bulk weight, angle of slip, weight composition. |
| | | | 3 | Factors affecting quality of fresh fish: intrinsic and extrinsic factors. |
| | | | 4 | Handling of fish onboard fishing vessels, Unit operations. |
| | | | 5 | Unloading fish, Fish pumps. |
| | | | 6 | Post-harvest Fishery losses, Methods to reduce losses. |
| | | | 7 | Handling of fish in landing centers, defects and modifications needed. |
| | | | 8 | Chill storage of fish: Heat load calculation, storage methods. |
| | | | 9-10 | Insulated boxes and insulation thickness, different types of ice, physical, chemical, microbiological and sensory changes during chill storage, iced storage shelf life, cold shock, physical, chemical and sensory methods of analysis. |
| | | | 11 | Different types of ice and their advantages. |
| | | | 12 | Melanosis and its prevention, discolouration in aquatic products, non-enzymatic browning. |
| | | | 13 | Depuration of bivalves. |
| | | | 14 | Transportation: Live fish/shell fish, Transportation of raw fish to local markets and processing centres, Improvements needed in transportation, Refrigerated transport systems. |
| | | | 15 | Classification of transport vehicles. |
| | | | 16 | Cold chain. |
| | | | ***PRACTICAL*** | |
| | | | 1-7 | Chill storage studies: Chemical, physical and sensory analysis, determination of shelf life. |
| | | | 8-16 | Handling of fish, bivalves, prawns, molluscs, |

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| | | | | Depuration, treatment with chemicals, evaluation of freshness of fish. |

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| **8** | **FPT.223** | **2+1=3** | | **FISH PRODUCTS, BY-PRODUCTS, VALUE ADDITION AND WASTE MANAGEMENT** |
| | | | ***THEORY*** | |
| | | | 1 | Principle of fish preservation and processing. |
| | | | 2 | Processing of fish by traditional methods– salting, sun drying, smoking, marinading and fermentation. |
| | | | 3 | Theory of salting, methods of salting– wet salting and dry salting. |
| | | | 4 | Drying and dehydration- theory, importance of water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. |
| | | | 5 | Packaging and storage of salted and dried fish. |
| | | | 6 | Different types of spoilage in salt-cured fish. |
| | | | 7 | Quality standard for salted and dry fish. |
| | | | 8 | Fish preservation by smoking-chemical composition of wood smoke and their role in preservation. |
| | | | 9 | Methods of smoking and equipment used for smoking. |
| | | | 10 | Carcinogenic compound in wood and methods to remove them. |
| | | | 11 | Hurdle technology in fish preservation and processing. |
| | | | 12-13 | Marinated and fermented fish products–role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. |
| | | | 14 | Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. |
| | | | 15 | Fish muscle structure, myofibrillar protein and their role in elasticity formation. |
| | | | 16 | Extruded products: theory of extrusion, equipment used, advantages of extruded products, methods of preparation of extruded products. |
| | | | 17 | Value addition. |
| | | | 18 | Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc |
| | | | 19 | Imitation products. |
| | | | 20 | HACCP in safe product production. |
| | | | 21 | Fish meal: dry reduction and wet reduction methods, specification, packaging and storage. |

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| | | | 22 | Fish oil: body oil, liver oil extraction, purification, preservation, storage, and application. |
| | | | 23 | Shrimp wastes: chitin, chitosan production, uses. |
| | | | 24 | Fish protein concentrate. |
| | | | 25 | Fish hydrolysate, partially hydrolyzed and deodorized fish meat, |
| | | | 26 | Functional fish protein concentrate and their incorporation to various products. |
| | | | 27 | Fish silage, acid silage, fermented silage and their application. |
| | | | 28-30 | Fish maws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer. |
| | | | 31 | Biochemical and pharmaceutical products. |
| | | | 32 | Utilization of seaweeds: agar agar, algin, carrageenan. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Preparation of salted fish, dried fish and smoked fish by different methods. |
| | | | 2 | Quality assessment of salted, dried and smoked fish. |
| | | | 3 | Preparation of prawn and fish pickles. |
| | | | 4 | Preparation of fermented fish sauce and marinade products. |
| | | | 5-6 | Preparation of surimi and surimi-based products. |
| | | | 7-9 | Preparation of diversified and value-added fish products. |
| | | | 10 | Quality assessment of market sample of dried and fermented fish products. |
| | | | 11-14 | Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure. |
| | | | 15 | Preparation of acid and fermented silage. |
| | | | 16 | Preparation of fish protein concentrate and fish hydrolysate. |

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| **9** | **SEC.226** | **0+2=2** | | **NET MAKING AND MENDING** |
| | | | ***PRACTICAL*** | |
| | | | 1 | Introduction to Fishing Nets |
| | | | 2 | Importance of nets in aquaculture and fishing |
| | | | 3 | Types of fishing nets (gill nets, seine nets, cast nets, trawl nets, etc.) |
| | | | 4 | Materials used in net making (nylon, polyethylene, monofilament, multifilament) |
| | | | 5 | Tools and Materials for Net Making & Mending: Needles |

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| | | | | and shuttles, Mesh gauges |
| | | | 6 | Twine types and their uses |
| | | | 7 | Knotting vs. knotless netting |
| | | | 8 | Net Making Techniques: Basic knots used in net making (reef knot, slip knot, square knot) |
| | | | 9 | Mesh formation techniques |
| | | | 10 | Weaving patterns for different net types |
| | | | 11 | Net Mending and Repair Techniques: Common damages in nets (tears, holes, fraying) |
| | | | 12 | Repair tools and materials |
| | | | 13 | Step-by-step mending techniques I |
| | | | 14 | Step-by-step mending techniques II |
| | | | 15 | Net Mending: Identifying Damages: Inspecting nets to detect broken meshes or weakened areas. |
| | | | 16 | Patch Repairing: Attaching patches to damaged sections using netting needles and twine. |
| | | | 17 | Patch Repairing: Attaching patches to damaged sections using netting needles and twine. |
| | | | 18 | Replacing Meshes: Removing and replacing torn meshes while maintaining the original mesh size and shape. |
| | | | 19 | Replacing Meshes: Removing and replacing torn meshes while maintaining the original mesh size and shape. |
| | | | 20 | Reinforcing Weak Points: Strengthening stress points, such as attachment areas, with additional twine or stitching. |
| | | | 21 | Reinforcing Weak Points: Strengthening stress points, such as attachment areas, with additional twine or stitching. |
| | | | 22 | Tension Adjustments: Ensuring uniform tension to prevent distortions in the net structure. |
| | | | 23 | Tension Adjustments: Ensuring uniform tension to prevent distortions in the net structure. |
| | | | 24 | Testing and Quality Control: Checking the strength and flexibility of repaired nets before use. |
| | | | 25 | Testing and Quality Control: Checking the strength and flexibility of repaired nets before use. |
| | | | 26 | Prevention of frequent net damage |
| | | | 27 | Net Treatment and Preservation: Coating and treating nets for durability |
| | | | 28 | Protection against UV rays, fouling, and wear |

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| | | | 29 | Proper storage and maintenance |
| | | | 30 | Safety and Environmental Considerations: Sustainable net usage to prevent overfishing |
| | | | 31 | Reducing ghost fishing (lost or abandoned nets) |
| | | | 32 | Proper disposal and recycling of old nets |

| **Post Semester IV (Exit option forward of UG-Diploma)** | | | | |
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| 1. | INT.222 | Internship**** | 10 (0+10) | **10 (0+10)** |
| **Sl.No.** | **Course Code** | **Course Title** | **Credit Hours** | **Total Credit hours** |

| **III Year** | | | **V Semester** | |
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| **1** | **AQ. 317** | **1+1=2** | | **FISH GENETICS AND BREEDING** |
| | | | ***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. |

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| | | | 15 | Seed certification and quarantine procedures. |
| | | | 16 | Cryopreservation of gametes. |
| | | | ***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 | Estimation of inbreeding coefficient. |
| | | | 10 | Preparation of Selection index for the selective breeding program. |
| | | | 11 | Mitotic and meiotic chromosome preparation. |
| | | | 12-13 | Demonstration of protocol of androgenesis, gynogenesis and polyploidy. |
| | | | 14 | Problems on gene and genotypic frequency. |
| | | | 15 | Gamete cryopreservation protocols and quality evaluation of fish milt. |
| | | | 16 | Study of risk factors in cryopreservation technique. |

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| **2** | **FRM.316** | **1+1=1** | | **FISH POPULATION DYNAMICS AND STOCK ASSESSMENT** |
| | | | | ***THEORY*** |
| | | | 1 | The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. |
| | | | 2 | Characteristics of unit and mixed stock. Data requirements for stock assessment. |
| | | | 3 | Segregation of stocks. |
| | | | 4 | Principles of stock assessment. |
| | | | 5 | Population age structure. Theory of life tables. |
| | | | 6 | Von Bertalanffy growth parameters. |
| | | | 7 | Graphical models. |
| | | | 8 | Monte Cario simulation model and ECOPATH model. |
| | | | 9 | Estimation of total fishing and natural mortality. |
| | | | 10 | The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. |
| | | | 11 | The concept of Maximum Sustainable Yield and Maximum Economic Yield. |
| | | | 12 | Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. |
| | | | 13 | Eumetric fishing. Open access fisheries. |

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| | | | 14 | Fisheries regulations. |
| | | | 15 | CPUE. Trawl selection and gillnet selection. |
| | | | 16 | Analytical models of fish stocks. |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Study of length – weight relationship, segregation of stock using direct methods. |
| | | | 3-4 | Study of analytical models: Beverton and Holt model. |
| | | | 5 | VBGF, |
| | | | 6 | Pauly's integrated methods, |
| | | | 7 | graphical models. |
| | | | 8-9 | Estimation of net selectivity coefficient. |
| | | | 10-13 | Fitting of surplus production model: Schaeffer model, Fox model. |
| | | | 14 | Study of yield isopleth diagrams. |
| | | | 15-16 | Micro-computer packages ELEFAN, FISAT. |

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| **3** | **AEM.314** | **1+1=2** | | **AQUATIC ECOLOGY AND BIODIVERSITY** |
| | | | | ***THEORY*** |
| | | | 1 | Aquatic environment, Flora and fauna: Components of aquatic systems. |
| | | | 2 | Aquatic productivity, nutrient cycles, energy flow, food chain. |
| | | | 3-4 | Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host-parasite relationship. |
| | | | 5-7 | Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices |
| | | | 8 | Ecological and evolutionary processes. Ecological niches |
| | | | 9-12 | Lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes |
| | | | 13 | Threats to aquatic biodiversity |
| | | | 14 | Conservation of habitats: marine parks and sanctuaries |
| | | | 15 | Conservation programs for endangered species, ex situ and in situ conservation, captive breeding and management of endangered species. |
| | | | 16 | Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices |
| | | | ***PRACTICAL*** | |
| | | | 1-5 | Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats |
| | | | 6-10 | Observation of adaptive characters and interrelationships |

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| | | | | like commensalisms, symbiosis, parasitism and predation |
| | | | 10-14 | Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. |
| | | | 15 | Collection, identification, and preservation of aqutic plants. |
| | | | 16 | Working out biodiversity indices |

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| **4** | **AAHM.313** | **2+1=3** | | **PHARMACOLOGY AND TOXICOLOGY** |
| | | | | ***THEORY*** |
| | | | 1-2 | Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. |
| | | | 3 | Route of Administration and Method of application to fish. |
| | | | 4-5 | Source of Drugs. Pharmacotherapeutic classification of drugs. |
| | | | 6-7 | Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation, and excretion of drugs |
| | | | 8 | Factors influencing drug metabolism. |
| | | | 9-11 | 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, halflife withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. |
| | | | 12-13 | Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. |
| | | | 14 | Salient features in drug acting on digestive system, nervous system and cardiovascular system. |
| | | | 15 | Drugs used in fish transportation. |
| | | | 16 | Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry. |
| | | | 17-18 | Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. |
| | | | 19 | Antigens – structure and types. epitopes, haptenes. |
| | | | 20 | Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. |
| | | | 21 | MHC complex – types, structure, and functions. |
| | | | 22 | Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells. |
| | | | 23 | Antigen-antibody reaction - Precipitin reactions, |

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| | | | | agglutination reactions, Microorganisms associated with fishes in health and disease. |
| | | | 24 | Defense mechanism in finfish and shellfish- specific and non specific immune system. |
| | | | 25 | Pathogenicity and virulence. Sources of infection, transmission of disease producing organisms, portals of infection. |
| | | | 26-27 | Immunity to bacteria, fungi and parasites Role of stress and host defense mechanism in disease development. |
| | | | 28 | Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. |
| | | | 29 | Serological methods in disease diagnosis. |
| | | | 30 | Immunostimulants –types, mechanism of action, modes of administration. |
| | | | 31-32 | Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping. |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Metrology, Prescription Writing, Preparation of drug solution |
| | | | 3 | Source and chemical nature of drugs. |
| | | | 4 | Incompatibility, Pharmaceutical technology |
| | | | 5 | Bioassay of drugs |
| | | | 6-7 | Animal models in Pharmacological experiments |
| | | | 8 | Methods of application of drugs in fish |
| | | | 9-10 | 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 ($Fl^-$) |
| | | | 11 | Qualitative detection of Nitrite and Nitrate, |
| | | | 12 | Detection of hydrocyanic acid |
| | | | 13 | Detection and Estimation of Mycotoxins |
| | | | 14 | Test for detection of alkaloids |
| | | | 15 | Estimation of $LD_{5O}$ and $ED_{5O}$ |
| | | | 16 | Demonstration of drug toxicity. |

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| **5** | **AAHM.314** | **1+1=2** | | **FISH IMMUNOLOGY** |
| | | | | ***THEORY*** |
| | | | 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 |

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| | | | | system. |
| | | | 3 | Antigens – structure and types. epitopes, haptenes. |
| | | | 4 | Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. |
| | | | 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 | Pathogenicity and virulence. Sources of infection, transmission of disease producing organisms, portals of infection. |
| | | | 10-11 | Immunity to bacteria, fungi and parasites. Role of stress and host defense mechanism in disease development. |
| | | | 12 | Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. |
| | | | 13 | Serological methods in disease diagnosis. |
| | | | 14 | Immunostimulants –types, mechanism of action, modes of administration. |
| | | | 15-16 | Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping. |
| | | | ***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 | 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. |

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| **6** | **FPT.314** | **1+1=2** | | **FISH FREEZING TECHNOLOGY** |
| | | | | ***THEORY*** |
| | | | 1 | Introduction to freezing technology; characteristics of fish and shellfish. |
| | | | 2 | Changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. |
| | | | 3 | Handling of fresh fish; sanitation in processing plants. |
| | | | 4 | Principles of low temperature preservations. |
| | | | 5 | Chilling of fish: methods and equipment for chilling; icing: quality of ice, ice making; refrigerated or chilled sea water, chilling rate; |
| | | | 6 | 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, freeze drying, |
| | | | 10 | Physico–chemical changes that occur during freezing, |
| | | | 11 | Mechanism of ice crystal formation; preparation of fish and shellfish 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 and shellfish: methods of thawing. |
| | | | 15 | Transportation of frozen fish and shellfish, cold chain, quality control, |
| | | | 16 | HACCP in freezing industry. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Sanitation and plant housekeeping. |
| | | | 2 | Chilling and freezing equipment, instruments. |
| | | | 3 | Packages and product styles. |
| | | | 4 | Methods of icing fish; |
| | | | 5 | Calculation of Cooling rate. |
| | | | 6 | Preservation by chilled sea water; |
| | | | 7 | Drawing of freezing curve |
| | | | 8 | Drawing of thawing curves. |
| | | | 9-12 | Freezing of different varieties of fish and shellfish; |
| | | | 13 | Estimation of drip. |
| | | | 14 | Determination of quality changes during frozen storage. |
| | | | 15 | Inspection of frozen fishery products. |
| | | | 16 | Visits to ice plants, cold storages, and freezing plants. |

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| **7** | **FPT.315** | **1+1=2** | | **FISH CANNING TECHNOLOGY AND PACKAGING** |
| | | | | ***THEORY*** |
| | | | 1 | Fish Canning Technology: Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials, their characteristics and suitability for canning. |
| | | | 2 | Classification of foods based on pH, commercial sterility, absolute sterility, pasteurization and sterilization. |
| | | | 3 | Canning process: Process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. |
| | | | 4 | Principles of thermal processing. Heat resistance of microorganisms, heat penetration studies, mechanism of heat transfer. Cold spot and its importance, convection and conduction type of packs. Process calculation by general/ graphical methods. Estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D concept. |
| | | | 5 | Canning of commercially important fin fishes, shellfishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. |
| | | | 6 | Quality standards, plant layout, hygiene and sanitation and waste disposal. |
| | | | 7 | Packaging: Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. |
| | | | 8 | Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use; Protective packaging with special reference to food. |
| | | | 9 | Printing for packaging and print identification. Closures of packaging, heat seals bottle closure. |
| | | | 10 | Principles of packaging: fresh produce handling and transportation. |
| | | | 11 | Packaging for retail sale and storage. Packaging equipment and machinery. Package design, evaluation and testing. |
| | | | 12 | Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. |
| | | | 13 | Laminations and co-extrusions. Retort pouch packaging - advantages and disadvantages. Biodegradable films, |

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| | | | | vacuum packaging, active packaging, Modified Atmosphere Packaging (MAP). |
| | | | 14 | Polymeric Packaging. Packaging requirements of fresh fish, frozen fish, canned fish. |
| | | | 15 | Transport worthiness of packaging materials, accelerated shelf testing. |
| | | | 16 | Safety and legislation aspects of packaging. Labelling and bar coding |
| | | | ***PRACTICAL*** | |
| | | | 1 | Types of cans, canning equipment and layout of cannery. |
| | | | 2-3 | Canning of different varieties of fish and shellfish. |
| | | | 4 | Cutout test of canned products. |
| | | | 5 | Examination of can double seam. |
| | | | 6 | Heat resistance of bacteria. |
| | | | 7 | Heat penetration in canned food, thermal process calculation by general method. |
| | | | 8 | Study of spoilage condition in canned products. |
| | | | 9 | Familiarization with various packaging materials and container for fish products. |
| | | | 10-16 | Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films. |

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| **8** | **FE. 313** | **2+1=3** | | **AQUACULTURE ENGINEERING** |
| | | | ***THEORY*** | |
| | | | 1 | Fish Farm: Definition, objectives, types of farms; fresh water, brackish water and marinefarms |
| | | | 2 | Selection of site for aqua farm: site selection criteria, pre-investment survey viz., accessibility,<br>physical features of the ground, detailed survey viz., site condition, topography, soil characteristics. |
| | | | 3 | Land Surveying: definition, principles of surveying, classification of surveying. |
| | | | 4 | Instruments used forchaining, chaining on uneven or sloping ground and error due to the incorrect chain length. |
| | | | 5 | Chainsurveying: definition, instruments used for setting out right angles, basic problems in chaining, |

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| | | | | cross-staff survey. |
| | | | 6 | Compass surveying: definitions, bearing, meridians, whole circle bearing system,reduced bearing system, theory of magnetic compass, prismatic compass. |
| | | | 7 | Levelling: definitions,methods of levelling, levelling instruments, terms and abbreviations, types of spirit levelling. |
| | | | 8 | Planetable surveying: instruments required, working operation, methods. |
| | | | 9 | Contour surveying: definition,contour interval, characteristics of contour. |
| | | | 10 | Contour surveying: Contouring methods and uses of contour. |
| | | | 11 | Soil and itsproperties: classification of soil; soil sampling methods; |
| | | | 12 | Three-phase system of soil, definitions of soilproperties and permeability of soil. |
| | | | 13 | Ponds: classification of ponds; excavated ponds, embankmentponds, barrage and diversion ponds; rosary system and parallel system. |
| | | | 15 | Planning of fish pond:layout planning, materials planning, manual planning, |
| | | | 16 | Comparison of square and rectangularponds, large and small ponds. |
| | | | 17 | Types of ponds: nursery ponds, rearing ponds and stocking ponds. |
| | | | 18 | Design of ponds, pond geometry; shape, size, bottom slope of pond etc., |
| | | | 19 | Construction of ponds,marking, excavation. |
| | | | 20 | Dykes: types of dykes viz., peripheral dykes, secondary dyke, design of dykes, |
| | | | 21 | Constructionof dykes. |
| | | | 22 | Water distribution system: canal, types of canals; feeder canal, diversion canaletc., Pipe line system. |
| | | | 23 | Water control structures: types of inlets and outlets and their construction. |
| | | | 24 | Water budget equation. Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. |
| | | | 25 | Site selection,planning and construction of coastal aqua farms. |
| | | | 26 | Brackish water fish farms: tide-fed, pump-fedfarms. |
| | | | 27 | Hatcheries: Site selection, infrastructural facilities; water supply system, main hatcherycomplex viz., |

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| | | | 28 | Layout plan and design of hatcheries: brood stock ponds, artemia hatching tanks,sheds etc. |
| | | | 29 | Raceway culture system: site selection, layout plan, types of raceway culture system viz.,parallel system, series system etc., |
| | | | 30 | Aerators: principles, classification of aerators and placement ofaerators. |
| | | | 31 | Pumps: purpose of pumping, types, selection of pump, total head, horse power calculation. |
| | | | 32 | Filters: types and constructions. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Evaluation of potential site for aquaculture. |
| | | | 2 | Land survey – chain surveying |
| | | | 3 | Land survey –compass surveying |
| | | | 4 | Land survey – leveling |
| | | | 5 | Land survey –plane table surveying |
| | | | 6 | Land survey –contouring; |
| | | | 7 | Soilanalysis for farm construction. |
| | | | 8 | Soilanalysis for farm construction. |
| | | | 9 | Design and layout plan of fresh water farms |
| | | | 10 | Design and layout plan of brackish water farms |
| | | | 11 | Design and layout plan of hatcheries. |
| | | | 12 | Design of farm structure: ponds, dykesand channels. |
| | | | 13 | Earth work calculations |
| | | | 14 | Estimation of water requirement |
| | | | 15 | Visit to freshwater fish farms. |
| | | | 16 | Visit to brackish water fish farms. |

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| **9** | **FEES.312** | **2+1=3** | | **STATISTICAL METHODS** |
| | | | ***THEORY*** | |
| | | | 1 | Definition of statistics |
| | | | 2 | Concepts of population, sample |
| | | | 3 | Census and sample surveys. |
| | | | 4 | Classification of data, frequency and cumulative frequency table. |
| | | | 5 | Diagrammatic and graphical representation of data - bar diagrams, pie-diagram. |
| | | | 6 | Diagrammatic and graphical representation of data - histogram, frequency polygon, frequency curve and Ogives. |
| | | | 7 | Important measures of central tendency - arithmetic mean, median and mode. Relative merits and demerits of these measures. |

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| | | | 8 | Important measures of dispersion - Range, Mean Deviation, Relative merits and demerits of these measures. |
| | | | 9 | Important measures of dispersion - Variance and Standard Deviation. Relative merits and demerits of these measures. |
| | | | 10 | Coefficient of variation; |
| | | | 11 | Normal Curve, Concepts of skewness |
| | | | 12 | Concepts of kurtosis |
| | | | 13 | Definitions of probability, mutually exclusive and independent events. |
| | | | | Conditional probability, addition and multiplication theorems |
| | | | 15 | Random variable, concepts of theoretical distribution; |
| | | | 16 | Binomial distributions and their use in fisheries |
| | | | 17 | Poisson distributions and their use in fisheries |
| | | | 18 | Normal distributions and their use in fisheries |
| | | | 19 | Basic concept of sampling distribution; |
| | | | 20 | Standard error and central limit theorem. |
| | | | 21 | Introduction to statistical inference |
| | | | 22 | General principles of testing of hypothesis, 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; relation between correlation and regression. |
| | | | 29 | Length-weight relationship in fishes |
| | | | 30 | Applications of linear regression in fisheries. |
| | | | 31 | Methodology for estimation of marine fish landings in India. |
| | | | 32 | Estimation of inland fish production in India and problems encountered. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Construction of questionnaires and schedules. |
| | | | 2 | Diagrams and frequency graphs |
| | | | 3-5 | Calculation of arithmetic mean, median, mode |
| | | | 6-7 | Calculation of, range, mean deviation, variance, standard deviation. |

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| | | | 8 | Exercises on probability |
| | | | 9-10 | Binomial and Poisson distributions, Area of normal curve, confidence interval for population mean |
| | | | 11-13 | Test of hypothesis based on normal, t, and chi-square distributions |
| | | | 14-15 | Computation of Simple correlation and regression |
| | | | 16 | Fitting of length-weight relationship in fishes |

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| **10** | **FEES.312** | **0+2=2** | | **STATISTICAL METHODS** |
| | | | ***PRACTICAL*** | |
| | | | **1-32** | **Education Tour*** |

| **III Year** | | | | **VI Semester** |
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| **1** | **AQ. 317** | **1+1=2** | | **FISH BIOTECHNOLOGY AND BIOINFORMATICS** |
| | | | ***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; |

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| | | | | 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 : Introduction. |
| | | | 15 | 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*** | |
| | | | 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 Culture Technology. |
| | | | 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. |

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| **2** | **AEM 325** | **1+1=2** | | **COASTAL ZONE MANAGEMENT** |
| | | | ***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 | Data Input, Data Management, Data Quality. |
| | | | 5 | Remote Sensing for Coastal Management. |
| | | | 6 | Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. |
| | | | 7 | Applications of GIS in aquatic resource identification. |
| | | | 8 | Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations. |
| | | | 9 | CRZ mapping |
| | | | 10 | Integrated Coastal Zone Management (ICZM); concept, application and case studies. |

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| | | | 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*** | |
| | | | 1 | Field visit to different coastal environments to study erosion of beaches. |
| | | | 2 | Identification of ecologically sensitive areas and protection. |
| | | | 3 | Study of CRZ, ICZM along the coastal belt. |
| | | | 4 | Study on implementation and violation of CRZ. |
| | | | 5 | Study of application of remote sensing and GIS. |
| | | | 6-9 | Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. |
| | | | 10-11 | Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation to combat disaster. |
| | | | 12-14 | Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. |
| | | | 15 | Working out biodiversity indices. |
| | | | 16 | Project preparation of EIA. |

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| **3** | **AEM 325** | **1+1=2** | | **MARINE BIOLOGY** |
| | | | ***THEORY*** | |
| | | | 1-2 | Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. |
| | | | 3-6 | Life in oceans - general account of major groups of phytoplankton, zooplankton and seaweeds. |
| | | | 7-9 | Environmental factors affecting life in the oceans- salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. |

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| | | | 10 | Vertical migration of zooplankton. |
| | | | 11 | Phytoplankton-Zooplankton relationship. |
| | | | 12-13 | Geographical and seasonal variation in plankton production. |
| | | | 14 | Plankton and fisheries. |
| | | | 15-19 | Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation. |
| | | | 20 | Mud banks: formation, characteristics. |
| | | | 21-22 | Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. |
| | | | 23-24 | Boring and fouling organisms. |
| | | | 25-27 | Nekton outline, composition of nekton, habitats of nekton. |
| | | | 28-29 | Bioluminescence. |
| | | | 30 | Indicator species. |
| | | | 31 | Blooms. |
| | | | 32 | Red tides: cause and effects. |
| | | | ***PRACTICAL*** | |
| | | | 1-5 | Study of common instruments used for collection of phytoplankton, zooplankton and benthos. |
| | | | 6-8 | Collection, preservation and analysis of phytoplankton. |
| | | | 9-10 | Collection, preservation and analysis of zooplankton. |
| | | | 11-16 | Collection, preservation and analysis seaweeds and inter tidal organisms. |

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| **4** | **AAHM.325** | **1+1=2** | | THERAPEUTICS IN AQUACULTURE |
| | | | ***THEORY*** | |
| | | | 1 | Scope and current scenario of therapeutics in aquaculture |
| | | | 2 | Chemotherapy: History, definition, terms usedand classification of AMA |
| | | | 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- |

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| | | | | 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*** | |
| | | | 1-2 | Regulations of drug use. |
| | | | 3-4 | Introduction to antimicrobials |
| | | | 5 | Preparation of potassium permanganate solution |
| | | | 6 | Preparation of weak Tincture Iodine. |
| | | | 7 | Minimum inhibitory concentration (MIC). |
| | | | 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 |

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| **5** | **FPT.326** | **1+1=2** | | **MICROBIOLOGY OF FISH AND FISHERIES PRODUCTS** |
| | | | ***THEORY*** | |
| | | | 1 | Introduction and history of microorganisms in foods. |
| | | | 2 | Role and significance of microorganisms in nature and in foods. |
| | | | 3 | Sources and types of microorganisms in fish and fishery products. |
| | | | 4 | Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food. |
| | | | 4-5 | Enumeration of microorganisms in food by conventional and rapid techniques. |
| | | | 6-7 | Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. |
| | | | 8 | Microbiology and spoilage of fresh, semi-processed, and processed fish and fishery products. |

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| | | | 9 | Indicators of microbiological quality of fish and fishery products. |
| | | | 10-14 | 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. |
| | | | 15 | Other biological hazards associated with fish and fishery products |
| | | | 16 | Marine toxins shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Sampling and processing of samples for microbiological investigation. |
| | | | 2-3 | Enumeration of microorganisms associated with finfish, shellfish, water and ice. |
| | | | 4 | Testing of water for potability. |
| | | | 5-11 | Isolation and identification of pathogenic bacteria associated with fish and fishery products - Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes and faecal streptococci. |
| | | | 12-13 | Biochemical tests for characterization of bacteria. |
| | | | 14-15 | Molecular methods for the detection of pathogenic microorganisms. |
| | | | 16 | Determination of MIC and MCC of chemical preservatives. |

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| **6** | **FE.324** | **1+1=2** | | **REFRIGERATION AND EQUIPMENT ENGINEERING** |
| | | | ***THEORY*** | |
| | | | 1 | Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work - A path function. |
| | | | 2 | Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy. |
| | | | 3 | Refrigeration: History of refrigeration, definition, principle, classification, Types of refrigeration |

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| | | | | systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system. |
| | | | 4 | Refrigeration plant: Layout of refrigeration plant, Construction and insulating materials used for the cold storage construction, Frozen product storage, capacity of cold storage, usage of Anteroom. |
| | | | 5 | Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle. |
| | | | 6 | Compressors: Definition, Types of compressors, construction, working principle, advantages and disadvantages. |
| | | | 7 | Evaporator: Definition, Types of Evaporators, construction, working principle, advantages and disadvantages. |
| | | | 8 | Condenser: Definition, Types of Condensers, Cooling Towers, construction, working principle, advantages and disadvantages. |
| | | | 9 | Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection. |
| | | | 10 | Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. |
| | | | 11 | Ice-plant: Ice plant planning, Brine tank construction, preparation of brine. Types of ice, storing of ice, Equipment used in ice plants. |
| | | | 12 | Freezers: Definition, Design, and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated Sea water (RSW), Chilled Sea water (CSW). Refrigerated transport. |
| | | | 13 | Cooling load: Unit of refrigeration, coefficient of performance (C.O.P), Refrigeration effect, study, and use of Psychrometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipment. |

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| | | | 15 | Theory of machines: Transmission of power, friction wheels, shaft, gears, belt, and Chain drive. Study of equipment used in fish processing with reference to canning, sausage, freeze drying and irradiation. |
| | | | 16 | Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant. |
| | | | **PRACTICAL:** | |
| | | | 1 | Drawing of Refrigeration and Fish processing machineries. |
| | | | 2 | Drawing of plant layout. |
| | | | 3 | Graphically represented symbols used in refrigeration. |
| | | | 4 | Handling and operation of compressors. |
| | | | 5 | Handling and operation of condensers. |
| | | | 6 | Handling and operation of evaporators. |
| | | | 7 | Handling and operation of expansion valves, low- and high-pressure switches. |
| | | | 8 | Study of auxiliary equipment: Receiver, oil charging, |
| | | | 9 | Study of auxiliary equipment: refrigerant charging, gas purging, |
| | | | 10 | Study of auxiliary equipment: oil draining, types of defrosting. |
| | | | 11 | Power transmission line diagram of different fish processing machineries. |
| | | | 12 | Visit to processing plant. |
| | | | 13 | Visit to refrigeration plant. |
| | | | 14 | Visit to ice plant. |
| | | | 15 | Visit to fishing harbor or landing center to study the fish hold, refrigerated fish rooms. |
| | | | 16 | Calculation on refrigeration effect and cooling load. |

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| **7** | **FE.325** | **1+1=2** | | **NAVIGATION AND SEAMANSHIP** |
| | | | ***THEORY*** | |
| | | | 1 | Principles of navigation –terms and definitions, finding positions and method of position fixing, magnetic |
| | | | 2 | Compass-parts and functions, cardinal, inter cardinal, three letter and lay points, pelorus and azimuth mirror, method of observation. |
| | | | 3 | Sextant -parts and functions, finding adjustable and nonadjustable errors and principles and use. |
| | | | 4 | Hand lead line – construction and markings and method of taking soundings. |

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| | | | | 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, |
| | | | 7 | International code of signals, flag signals mars code and storm signals general system, brief system and extended system, storm signals stations 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 of fire at sea, fire prevention on board the vessel and method of firefighting at sea and recommended firefighting 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 vessels toface heavy weather. Temporary repairs for leaks constructions of the steering system and rigging emergency jury rudder. |
| | | | 15 | Types of anchors and their applications: 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. Method of leaving vessels from the berth. |
| | | | **PRACTICAL** | |
| | | | 1 | Anchoring. |
| | | | 2 | Coming alongside the berth and leaving. |
| | | | 3 | Practicing the different types of knots and wire splices. |

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| | | | 4 | Use of magnetic compass. |
| | | | 5 | Use of GPS. |
| | | | 6 | Use of Echo-sounder. |
| | | | 7 | Finding positions by latitudes and longitudes. |
| | | | 8 | Finding positions by position lines, |
| | | | 9 | Finding positions by cross-bearing method |
| | | | 10 | Finding positions by cross-bearing method. |
| | | | 11 | Finding positions by horizontal sextant angles, |
| | | | 12 | Finding positions by vertical sextant angle. |
| | | | 13 | Finding positions by running fix. |
| | | | 14 | Finding position by speed, distance and time. |
| | | | 15 | Finding set and drift of current and finding course. |
| | | | 16 | Steering course and finding position by counter acting the current observation of RADAR. |

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| **8** | **FEES.323** | **2+1=3** | | **FISHERIES ECONOMICS** |
| | | | ***THEORY*** | |
| | | | 1 | Introduction to fisheries economics. |
| | | | 2 | Basic economic terminologies - micro and macro-economics, positive and normative economics, Environmental economics |
| | | | 3 | Resource, scarcity, farm-firm relationships, production, Contribution of fisheries sector to the economic development of country |
| | | | 4 | Micro-economics: theories of demand, supply. |
| | | | 5 | Market - equilibrium price, consumption, utility, consumer's surplus. |
| | | | 6 | Elasticity - price, income, cross, Application of elasticity in fisheries managerial decision. |
| | | | 7 | Farm production economics - production functions in capture and culture fisheries. |
| | | | 8 | Costs and returns. Breakeven analysis of fish production system. |
| | | | 9 | Concepts of externalities and social cost. |
| | | | 10 | Factors of production |
| | | | 11 | Marginal cost and return, Law of diminishing marginal return, |
| | | | 12 | Returns to scale, Economies of scale and scope. |
| | | | 13 | Revenue, profit maximization, measurement of technological change. |
| | | | 14 | Farm planning |
| | | | 15 | Farm budgeting. |
| | | | 16 | Significance or importance of marginal cost. |

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| | | | 17 | Macro-economics: Introduction to national income, accounting. Measurement and determinants of national income |
| | | | 18 | Contribution of fisheries to GNP and employment. |
| | | | 19 | Balance of payments, Economic growth and sustainable development |
| | | | 20 | Globalisation: dimensions and driving Forces. |
| | | | 21 | Introduction to GATT and WTO. |
| | | | 22 | WTO Framework - Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), |
| | | | 23 | Seafood Export Regulations, Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures |
| | | | 24 | Fisheries Subsidies and WTO. |
| | | | 25 | Fisheries Trade and Environment; |
| | | | 26 | Protests against globalisati Shifting demand and surplus curve and its important in fish price.on and WTO. |
| | | | 27 | Intellectual Property Rights (IPR) and different forms. |
| | | | 28 | Patents and patenting process |
| | | | 29 | Agreement on TRIPS, Bio-piracy. |
| | | | 30 | GMOs in fisheries |
| | | | 31 | Salient features of Indian Patent (Amendment) Act 2005. |
| | | | 32 | Overview of Patents in Indian fisheries sector. |
| | | | ***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. |
| | | | 6-9 | Production function - production with one or two variable inputs. |
| | | | 10-11 | Shifting demand and surplus curve and its important in fish price. |
| | | | 12 | Economic analysis on cost, return and break even of fish farm. |
| | | | 13 | Economic analysis on cost, return and break even of shrimp farm. |
| | | | 14 | Economic analysis on cost, return and break even of seed production unit. |

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| | | | 15 | Economic analysis on cost, return and break even of Fish processing plant |
| | | | 16 | Economic analysis on cost, return and break even of Export unit. |

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| **9** | **FEES.324** | **1+0=1** | | **FISHERIES POLICY AND LAWS** |
| | | | ***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 the 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. |
| | | | 7 | Implementation of community-based resource management plans. |
| | | | 8 | Historical review of fisheries development and management in India. |
| | | | 9 | Historical review of fisheries development and management in world. |
| | | | 10 | International agencies/organizations for promotion of fisheries worldwide. |
| | | | 11 | Fisheries legislation: Overview of fisheries and aquaculture legislations in India. |
| | | | 12 | Indian Fisheries Act, 1897. |
| | | | 13 | Environmental legislation; Water Act, |
| | | | 14 | Environmental legislation; Air Act |
| | | | 15 | Environmental legislation; Environmental (Protection) Act. |
| | | | 16 | International environmental legislation and its impact on fisheries. |

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| **10** | **FEES.325** | **1+1=2** | | **FISHERIES CO-OPERATIVE AND MARKETING** |
| | | | ***THEORY*** | |
| | | | 1 | Principles and objectives of co-operation, co-operative movement in fisheries in India |
| | | | 2 | Structure, functions, status and problems of fisheries |

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| | | | | 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 Core marketing concepts |
| | | | 8 | 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 in 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*** | |
| | | | 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. |

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| | | | 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. |

| **Elective Courses (Major)** | | | | |
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| **IV Year** | | | | **VII Semester** |
| **1** | **AQ.419** | **2+1=3** | | **OPEN-WATER AQUACULTURE** |
| | | | ***THEORY*** | |
| | | | 1 | Global and Indian Scenario of Open Water Aquaculture: Status, Utilization, and Prospects for Production Enhancement |
| | | | 2 | Open Water Limnology: Key Features and Significance in Fisheries Development |
| | | | 3 | Management, Conservation, and Future Prospects of Open Water Fisheries |
| | | | 4 | Role of Cage Culture in Enhancing Fish Production in Open Water Bodies |
| | | | 5 | History, Advantages, and Applications of Cage Culture in Fisheries |
| | | | 6 | Site Selection, Cage Materials, and Structural Design for Cage Culture |
| | | | 7 | Construction of Cages: Bioengineering Challenges and Solutions |
| | | | 8 | Species Selection and Rearing Techniques in Cage Culture |
| | | | 9 | Constraints and Challenges in Cage Culture Practices |
| | | | 10 | Economic Aspects and Profitability of Cage Culture |
| | | | 11 | Integration of Cage Culture with Other Farming Systems |
| | | | 12 | History and Development of Pen Culture |
| | | | 13 | Pen Materials, Fabrication, and Structural Design |
| | | | 15 | Fish Breeding and Seed Rearing in Pen Culture |
| | | | 16 | Grow-out Systems and Species Selection in Pen Culture |
| | | | 17 | Challenges and Constraints in Pen Culture Practices |
| | | | 18 | Economic Aspects and Viability of Pen Culture |
| | | | 19 | Species Selection, Quality, and Stocking Strategies in Pen |
| | | | 20 | Natural Feed Enhancement Techniques for Open |

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| | | | | Water Aquaculture |
| | | | 21 | Supplementary Feeding Strategies in Cages and Pens |
| | | | 22 | Stock Assessment Methods in Open Water Aquaculture |
| | | | 23 | Harvesting Techniques and Post-Harvest Management in Open Water Systems |
| | | | 24 | Conflicts of Open Water Aquaculture with Irrigation, drinking and Hydroelectric Projects |
| | | | 25 | Environmental Impact of Open Water Aquaculture: Salinity Intrusion and Effluent Discharge |
| | | | 26 | Eutrophication and Chemical Contaminants in Open Water Aquaculture |
| | | | 27 | Destruction of Natural Habitats: Paddy Fields, Mangroves, and Ecosystem Disturbances |
| | | | 28 | Social Issues and Resource Conflicts in Open Water Aquaculture |
| | | | 29 | Ranching in Open Waters: Concept and Applications |
| | | | 30 | Impact of Climate Change on Open Water Aquaculture |
| | | | 31 | Role of Indigenous and Exotic Fish Species in Open Water Aquaculture |
| | | | 32 | Policy, Regulations, and Governance in Open Water Aquaculture |
| | | | ***PRACTICAL*** | |
| | | | 1 | Preparation of charts on the present situation of open water fisheries productivity: Small, medium and large reservoirs |
| | | | 2 | Preparation of charts on the present situation of fisheries productivity: Rivers, lakes and estuaries |
| | | | 3 | Preparation of charts on the present situation of fisheries productivity: Floodplain and wetlands, Backwaters and Lagoons |
| | | | 4 | Preliminary observations on hydrobiological parameters of the selected rivers: Physical and chemical factors |
| | | | 5 | Preliminary observations on hydrobiological parameters of the selected reservoirs: 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 backwaters on the changing trends in capture fisheries profile |
| | | | 8 | Detailed case studies of selected lagoons/ esturies on the changing trends in capture fisheries profile |

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| | | | 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 culture |
| | | | 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 operation. |
| | | | 16 | Field visit to pen culture site to acquaint with construction details and operation. |

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| **2** | **FRM.417** | **2+1=3** | | **SUSTAINABLE FISHERIES MANAGEMENT AND CONSERVATION** |
| | | | ***THEORY*** | |
| | | | 1-2 | Inland fisheries: Major inland fisheries resource of the World-India-Overview. |
| | | | 3-4 | State of the fisheries- Fishing gears-and crafts- Catch composition. |
| | | | 5-7 | Marine fisheries: Major marine fisheries resources of the world and India. |
| | | | 8-10 | Overview- State of the fisheries -Fishing gears – Catch composition-pelagic, Demersal, Oceanic, Deep-sea. |
| | | | 11-13 | Sustainability issues in fisheries: Ghost fishing-Overexploitation, Overcapacity, pollution, Habitat degradation/ biodiversity loss. |
| | | | 14-16 | Damming of rivers. Interlinking of rivers, Environmental flows; Fishing Conflicts-Exotics; Trans-boundary issues, IUU fishing, inter-linking of rivers-Climate change, By-catch and discards. |
| | | | 17-19 | Principle of fisheries Management- Management approaches-By catch reduction- Rebuilding fishery, Rebuilding stock, Co-management - right based fishing input control (fishing efforts, mesh regulations, fishing ban, licensing, capital investments, etc.) - output control (catch quotas, minimum legal size, etc.). |
| | | | 20 | Fishery reserve-technical measures. |
| | | | 21-23 | Spawning aggregates; trade agreement- Market-based instruments; Access right – Catch sharing-balanced |

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| | | | | Fishing-Subsidy-certification and Traceability-Sustainable management approach in lake, Reservoir and beels. |
| | | | 24-26 | Functions and importance of Aquatic habitats: Mangrove, Corals, Seagrass beds, and dunes, Turtle nesting grounds, horseshoe crab habitat; Role and functions of aquatic habitat; Human activities and pollution sources; Effects of Conservation Practices on Aquatic Habitats and Fauna. |
| | | | 27-28 | Aquatic habitat conservation: Freshwater habitat and Marine water habitat; Erosion and sediment control-transplantation-stocking-population stabilization. |
| | | | 29 | Fish refugee- ex-situ conservation. |
| | | | 30 | Responsible fishing practices Precautionary management –Fisheries co-management: Right-based fishing - Catch sharing access right - Balanced fishing. |
| | | | 31-32 | Technical Guidelines of CCRF for responsible fishing; National and International treaties (National policy on marine fisheries-2017; National policy on inland fisheries 2019; MFRA's; UNCLOS; UNFSA; IOTC). |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Capture fisheries observation at lakes, reservoirs, river stretches, and marine landing centers. |
| | | | 3-4 | Species landings analysis. Interaction with manager's Co-operative societies and stakeholders. |
| | | | 5-6 | Fleet capacity assessment. |
| | | | 7-8 | Visit to fishery reserves to understand management. |
| | | | 9-10 | Field survey and observation of fisheries issues. |
| | | | 11-12 | Development of management plan. |
| | | | 13-14 | Suggest management plan for aquatic habitat protection- permit application form. |
| | | | 15 | Valuation of ecosystems – awareness on fisheries resource conservation. |
| | | | 16 | Visit to reservoir and assess the threats and developing plan for stock rebuilding. |

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| **3** | **AEM.417** | **2+1=3** | | **FISHERY OCEANOGRAPHY** |
| | | | ***THEORY*** | |
| | | | 1 | Introduction to Oceanography. Different branches of Oceanography |
| | | | 2-3 | Earth and the ocean basin, distribution of water and land; |
| | | | 4-6 | Relief of sea floor; Major feature of topography and |

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| | | | | terminology; major divisions. Relief in Indian oceans. |
| | | | 7-10 | Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity |
| | | | 11-12 | 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. |
| | | | 12-14 | General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram |
| | | | 15-17 | Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. |
| | | | 18-21 | 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. |
| | | | 22 | El Nino and Southern Oscillation. |
| | | | 23-25 | Water masses of Indian oceans. |
| | | | 26-30 | 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. |
| | | | 31-32 | Environmental factors influencing the seasonal variations in fish catch in the Arabian Sea and the Bay of Bengal. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Study of ocean bottom topography |
| | | | 2 | Study of on board accessories of oceanographic vessel |
| | | | 3 | Study water transparency measuring device |
| | | | 4-5 | Study of sub surface water temperature measurement devices ) Reversing Thermometer, Bathythermograph, |
| | | | 6 | Study of Nansen reversing bottle |

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| | | | 7-10 | Study of Bottom Sediment Collecting Device - Phleger corer ,Ekman Grab Peterson Grab, Lafond Dietz Snapper |
| | | | 11-14 | Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water. |
| | | | 15-16 | Use of tide tables. Fisheries forecasting systems. Oceanographic equipment and fish-finding devices |

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| **4** | **FPT.417** | **2+1=3** | | **QUALITY ASSURANCE OF FISH AND FISHERY PRODUCTS** |
| | | | ***THEORY*** | |
| | | | 1 | Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. |
| | | | 2 | Preharvest and post-harvest factors affecting quality. |
| | | | 3 | Assessment of quality changes in fresh and iced fish. |
| | | | 4 | Quality changes during processing. |
| | | | 5-7 | Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance program for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze-dried products. |
| | | | 8 | Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. |
| | | | 9 | Food laws and standards, national and international legislation, mandatory and non-mandatory standards. |
| | | | 10 | Role of export inspection council and export inspection agency and MPEDA in fish and fishery products. |
| | | | 11 | Executive instructions on fish and fishery products, Legislation for export quality assurance in India. |
| | | | 12 | Certification system for fish and fishery products. |
| | | | 13 | Legal basis for monitoring products related EU requirements. |
| | | | 14 | Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish and fishery products for export. |
| | | | 15 | Complaint handling procedure on fish and fishery products. |
| | | | 16 | Interpretation of test reports and limits on chemical residues. |
| | | | 17 | GOI notifications on fish and fishery products. |
| | | | 18 | General requirements for export of fish and fishery products to the EU. |
| | | | 19 | International regulatory framework for fish safety and |

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| | | | | quality. |
| | | | 20 | Prerequisites to HACCP. |
| | | | 21-25 | Labelling for product traceability and Labelling requirements - National and international, legislation on labelling, components of traceability codenutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people. |
| | | | 26 | EU legislation on traceability of fish and fish products. |
| | | | 27-28 | Assessment of food safety program, The HACCP for seafood industries and protection of food from adulterants. |
| | | | 29 | Standards for sea foods. FSSAI, FDA, ISO. |
| | | | 30 | Use of additives in seafood processing as quality enhancers. |
| | | | 31 | Seafood safety, authenticity, traceability. |
| | | | 32 | Waste management in seafood processing. |
| | | | ***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, |
| | | | 11-16 | Equipment sanitation and personnel hygiene. |

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| **5** | **AQ. 411** | **2+1=3** | | **SMART AQUACULTURE PRODUCTION SYSTEMS** |
| | | | ***THEORY*** | |
| | | | 1 | Introduction: An overview of global aquaculture production, demand- consumption scenario and emerging trends. |
| | | | 2 | Present status, Constraints and future prospects in India and the world. |
| | | | 3 | Aquaculture practices indifferent parts of the world, Enhancing carrying capacity in culture systems. |
| | | | 4 | Biofloc technology: Principles of biofloc. |
| | | | 5 | Biofloc technology: Different carbon sources. |
| | | | 6 | Biofloc technology: Design of aeration system and biofloc reactor. |
| | | | 7 | Biofloc technology: Biofloc reactor. |
| | | | 8 | Biofloc technology: Carrying capacity, C: N ratio. |

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| | | | 9 | Biofloc technology: Harvesting of biofloc, Biofloc quality and quantity. |
| | | | 10 | Biofloc technology: Biofloc as feed ingredient. |
| | | | 11 | Biofloc technology: Stocking of fish and shellfish species. |
| | | | 12 | Bioremediation in wastewater aquaculture. |
| | | | 13 | Minimal water exchange aquaculture systems: Principles of closed system farming, RAS, Components. |
| | | | 14 | Minimal water exchange aquaculture systems: Design of mechanical and biological filters for the water reuse system, |
| | | | 15 | Minimal water exchange aquaculture systems: Sludge removal,disposal of wastes and control of pollution to the environment. |
| | | | 16 | Minimal water exchange aquaculture systems: Design of RAS, biofiltration and Nitrifiers. |
| | | | 17 | Minimal water exchange aquaculture systems: Suitable cultivable species for indoor culture systems, polyhouses. |
| | | | 18 | Aquaponics: Principles, Components and Design of different aquaponics systems. |
| | | | 19 | Aquaponics: Components in aquaponics, ratio of fish and plants |
| | | | 20 | Aquaponics: Water quality and system maintenance, Resource utilization, Nutrient recycling and zero discharge of nutrients. |
| | | | 21 | Running water systems: Flow-through system. |
| | | | 22 | Running water systems: Raceways (IPR). |
| | | | 23 | Running water systems: IMTA. |
| | | | 24 | Running water systems: Partitioned Aquaculture Systems (PAS). |
| | | | 25 | Running water systems: Aquamimicry systems. |
| | | | 26 | Other farming methods: Cluster farming. |
| | | | 27 | Other farming methods: Organic farming. |
| | | | 28 | Other farming methods: Satellite farming. |
| | | | 29 | Other farming methods: Co-operative farming. |
| | | | 30 | Other farming methods: Conservation aquaculture. |
| | | | 31 | Network of production and marketing aspects. |
| | | | 32 | Economics of super intensive farming systems, Advantages and disadvantages. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Design of biofloc systems. |
| | | | 2 | Fabrication of biofloc systems. |

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| | | | 3 | Performance evaluation of biofloc systems. |
| | | | 4 | Different equipment in closed grow-out system: Aerators. |
| | | | 5 | Different equipment in closed grow-out system: Biofilters. |
| | | | 6 | Different equipment in closed grow-out system: RAS. |
| | | | 7 | Different equipment in closed grow-out system: Raceways. |
| | | | 8 | Different equipment in closed grow-out system: IMTA. |
| | | | 9 | Different equipment in closed grow-out system: IMTA and PAS. |
| | | | 10 | Different equipment in closed grow-out system: Aquaponics systems. |
| | | | 11 | Plankton and microbial analysis of biofloc. |
| | | | 12 | Studies on different C: N ratio. |
| | | | 13 | Nutrient analysis in aquaponics. |
| | | | 14 | Visit to hatcheries with super-intensive models. |
| | | | 15 | Identification and understanding the network of the systems; Market analysis for the produces. |
| | | | 16 | Analysis of economic advantages- Case studies. |

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| **6** | **AAHM.416** | **2+1=3** | | **FISH AND SHELLFISH PATHOLOGY** |
| | | | ***THEORY*** | |
| | | | 1-2 | General pathology: Brief introduction to finfish and shellfish anatomy and histology |
| | | | 3-5 | General pathology of finfish and shellfish Pathophysiology of fish:Pathophysiology of finfish and shellfish |
| | | | 6-7 | Stress and stressors; General adaptation syndrome; |
| | | | 8-9 | Types of cellular adaptations; Hypertrophy, hyperplasia, Atrophy and metaplasia, Neoplasia. |
| | | | 10-15 | Inflammation and cellular pathology: Reversible cellular changes and accumulations; Fatty changes and pigments; Inflammation; Causes of inflammation; Cellular responses to inflammation; Mediators; various patterns of inflammation;The difference between acute and chronic inflammation; Tissue repair; Cell death; Necrosis, Apoptosis, Autophagy; Necroptosis; Their mechanisms and different morphological patterns. |
| | | | 16-19 | Clinical pathology: Normal constituents of blood; |

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| | | | | Alterations in the haematological parameters and enzymes with reference to different pathological conditions in finfish; Haematology of shrimp and molluscans; Clotting mechanisms; other host defence mechanisms. |
| | | | 20-26 | Systemic pathology of finfish: Systemic pathology of finfish integumentary system, Respiratory system, Vascular system, Digestive system, Excretory system, Nervous system, Musculoskeletal and Endocrine system due to bacteria, Parasites and viruses |
| | | | 27-31 | Systemic pathology of shellfish: Major pathological changes due to infectious diseases in the integumentary system, Lymphoid organ, Gill, Hepatopancreas, Gut and other organs of crustaceans |
| | | | 32 | Major pathological changes due to diseases in molluscans. |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Necropsy techniques |
| | | | 3 | Collection and fixation of tissues |
| | | | 4-6 | Complete histology and different staining techniques. |
| | | | 7-10 | Examination and interpretation of the pathological changes in fish tissues. |
| | | | 11-12 | Complete blood profile of finfish. Routes of blood collection from fish. |
| | | | 13-14 | Different staining techniques for blood cell visualization.Morphology of blood cells |
| | | | 15 | Total leucocyte count. |
| | | | 16 | Differential leucocyte count |

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| **7** | **AAHM.417** | **2+1=3** | | **DISEASE DIAGNOSTIC TECHNIQUES** |
| | | | ***THEORY*** | |
| | | | 1-2 | Introduction to fish disease diagnosis: Introduction to disease diagnosis; different roles and levels of diagnosis in aquaculture |
| | | | 3 | The evolution of diagnostic techniques in aquaculture |
| | | | 4-5 | A brief introduction to diagnostic features of important diseases of finfish and shellfish. |
| | | | 6-10 | Microbiological techniques: Safety in microbiology laboratory; Bio-safety levels and risk groups; Techniques in sterilization; Preparation of microbiological media. |
| | | | 11-14 | Culture Microscopic techniques: Bright field, Darkfield, Phase contrast, Fluorescence and electron microscopy |

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| | | | 15-18 | Cell culture-based diagnostic methods: Introduction to cell culture techniques; Different cells used for virus isolation; CPE. |
| | | | 19-24 | Protein-based diagnostic methods: Antibody-based diagnostic methods (immunohistochemistry, ELISA, western blotting, lateral flow assay etc.), Hybridoma technology and monoclonal-antibodybased diagnosis |
| | | | 25-29 | Nucleic-acid based diagnostic methods: Nucleic acid amplification methods; Types of PCR: Reverse transcriptase-PCR, Real-time PCR and Other variants of PCR |
| | | | 30-32 | In situ hybridization; Dot blot assay; LAMP etc. |
| | | | ***PRACTICAL*** | |
| | | | 1-3 | Sample collection and preparation for microscopic, microbiological, virological and histopathological analysis |
| | | | 4-6 | Culture of microorganisms using conventional methods |
| | | | 7-8 | Antibiotic sensitivity testing |
| | | | 9-11 | Serological techniques in disease diagnosis: SDS-PAGE, Western blotting, ELISA, etc. |
| | | | 12 | Cell culture techniques |
| | | | 13 | Molecular techniques in disease diagnosis |
| | | | 14 | Nucleic acid extraction, estimation and different PCR-based diagnosis |
| | | | 15-16 | Familiarization of some of the commercially available diagnostic kits used in aquatic animal disease diagnosis. |

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| **8** | **AEM.419** | **2+1=3** | | **AQUATIC POLLUTION** |
| | | | ***THEORY*** | |
| | | | 1-2 | Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment. |
| | | | 3-4 | Classification of pollution; Physical, chemical and biological classification of water pollution- description of terminologies. |
| | | | 5-6 | Sewage and domestic wastes; composition and pollution effects, sewage treatment and its reuse. |
| | | | 7-8 | Agricultural wastes; organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand (BOD, COD), Oxygen budget; |
| | | | 9-10 | Biological effects of organic matter. Excessive plant nutrients: |

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| | | | 11 | Eutrophication; Red tides and fish kills. |
| | | | 12-13 | Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); |
| | | | 14-16 | Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. |
| | | | 17 | Bioremediation and Phytoremediation. |
| | | | 18-20 | Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; |
| | | | 21-23 | Ecological Impact of Oil pollution - Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; |
| | | | 24-26 | Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion; |
| | | | 27-28 | Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, |
| | | | 29 | Physical and chemical nature of possible effluents from major industries in India. |
| | | | 30-31 | Monitoring and control of pollution: Biological indicators of pollution. |
| | | | 32 | Solid waste management. |
| | | | ***PRACTICAL*** | |
| | | | 1-7 | Estimation of physio-chemical characteristics of polluted waters: Colour, Odour, Turbidity, pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphone, phosphates, ammonia, nitrates, nitrites, heavy metals and Oil and grease in water. |
| | | | 8-9 | Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. |
| | | | 10-11 | Bacteriological tests of waste water: Coliform tests, IMVIC test, standard plate count. |
| | | | 12-13 | Methods of enumerating bacterial biomass in waters and waste waters. |
| | | | 14-16 | Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study. |

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| **9** | **AEM.411** | **2+1=3** | | **ANALYTICAL TECHNIQUES IN AQUATIC ENVIRONMENTAL STUDIES** |
| | | | ***THEORY*** | |

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| | | | 1-2 | Qualitative and quantitative analytical techniques including Gravimetric and volumetric analyses used in environmental science, |
| | | | 3-4 | Sampling techniques and procedures, |
| | | | 5-7 | Factors affecting the choice of analytical techniques, Interferences and their minimization, |
| | | | 8 | Laboratory safety measures. |
| | | | 9-15 | Photometric techniques: Theory, instrumentation and application of spectrophotometry and spectroscopy, AAS, ICP-MS, Biosensor, Microscopic Techniques etc. |
| | | | 16-19 | Theory and applications of electrophoresis, Principles and uses of ultra-centrifugation, Tracer Techniques, Isotopes in environmental analysis. |
| | | | 20-24 | Separation techniques: Chromatography – theory, instrumentation and applications of thin layer, paper, ion-exchange, size exclusion, high performance liquid and gas chromatography. |
| | | | 25-27 | Methods of preparing biological samples for chromatographic analysis GC-MS Unit. Bioanalysis techniques: |
| | | | 28-29 | Immunoassay – Principle, methods and applications and Biosensors – components, characteristics, applications, impacts and challenges. |
| | | | 30-32 | Nanotechnology: Preparation of nanoparticles, characterization and applications. |
| | | | ***PRACTICAL*** | |
| | | | 1-3 | Eutrophication studies in natural waters - tanks and ponds |
| | | | 4-5 | Estimation of bio-indicator organisms in polluted waters. |
| | | | 6-7 | Bioremediation experiments using different bio-agents. |
| | | | 8-11 | Use of UVvisible Spectrophotometer for phosphate, nitrate other ions. |
| | | | 12-13 | AAS for analysis of heavy metals. |
| | | | 14-16 | Use of HPLC and GC-MS for analysis of pesticide and other volatile and semi volatile organic substances. |

| **Elective Courses (Minor)** | | | | |
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| **IV Year** | | | **VII Semester** | |
| **1** | **AQ. 317** | **1+1=2** | **COLDWATER AQUACULTURE AND RECREATIONAL FISHERIES** | |
| | | | ***THEORY*** | |
| | | | 1 | Introduction: Status of coldwater fisheries in World with special reference to India |

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| | | | 2 | Biology, breeding and culture of troutsOncorhynchus *mykiss, Salmo trutta fario, Schizothoraichthysesocinus, S. longipinnis, S. niger, Schizothoraxrichadsonii*). |
| | | | 3 | Biology, breeding and culture of mahseer *(Tor putitora, Tor tor, Tor khudree)*. |
| | | | 4 | Biology, breeding and culture of common carp *(Cypinus carpio cummunis, Cyprinus carpio specularis)*. |
| | | | 5 | Specific environmental parameters pertaining to cold water fish culture and metabolic interaction |
| | | | 6 | Feeds suitable for cold water aquaculture. |
| | | | 7 | Culture of cold-water fishes: Construction and management of cold-water fish farms. |
| | | | 8 | Culture of cold-water fishes: Effect of exotic fish introduction on indigenous fish fauna. |
| | | | 9 | Culture of cold-water fishes: Polyculture of exotic carp in mid hill region based on three Chinese carps. |
| | | | 10 | Culture of cold-water fishes: Post-harvest and harvest issues in trout with regards to cold water species |
| | | | 11 | Culture of cold-water fishes: Special factors for consideration in cold water fish seed production and nursery rearing. |
| | | | 12 | Introduction to sport fisheries: Sports fishes and their life history |
| | | | 13 | Equipment for sports fishing, fishing methods, area suitable for sports fishing, etc. |
| | | | 14 | Management and conservation of sports fisheries through aquaculture |
| | | | 15 | Sport fisheries and tourism, Recreational aquaculture |
| | | | 16 | Potential and Innovative Strategies for the Development of coldwater aquaculture in India-problems encountered in fisheries development of rivers supporting cold water fisheries. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Identification of coldwater fish species-trouts. |
| | | | 2 | Identification of coldwater fish species-mahseer. |
| | | | 3 | Identification of coldwater fish species-common carps. |
| | | | 4 | Primary and secondary sexual characters in cold water fishes-trouts. |
| | | | 5 | Primary and secondary sexual characters in cold water fishes-mahseer. |
| | | | 6 | Primary and secondary sexual characters in cold water fishes-common carp. |

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| | | | 7 | Different breeding methods for cold water fishes-trouts. |
| | | | 8 | Different breeding methods for cold water fishes-Mahseer and common carp. |
| | | | 9 | Identification of larval stages of trout. |
| | | | 10 | Identification of larval stages of mahseer. |
| | | | 11 | Preparation of hatchery layout for coldwater fishes-trouts. |
| | | | 12-13 | Preparation of hatchery layout for coldwater fishes-mahseer |
| | | | 14 | Preparation of hatchery layout for coldwater fishes-common carp |
| | | | 15 | Studies on different types of sports fishing equipment. |
| | | | 16 | Visit to coldwater fish hatcheries and farms. |

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| **2** | **AEM.418** | **2+0=2** | **CLIMATE CHANGE AND ITS IMPACT ON FISHERIES** | |
| | | | ***THEORY*** | |
| | | | 1-5 | Weather and climate, Greenhouse effect, Radiative balance, Climatic migration, Carbon Sequestration and trading, |
| | | | 6-7 | Projected trends of climate change and disasters |
| | | | 8-10 | Climate change, its impacts, Aquatic ecosystem, Capture and culture fisheries, |
| | | | 10-12 | Carbon footprint in fisheries and aquaculture. |
| | | | 13-16 | Oceanographic factors in fisheries: Effects of physio-chemical and biological oceanographic factors on adaptation; Behaviour, abundance and distribution of aquatic organisms; Primary and secondary productivity in ocean under changing climate |
| | | | 17-20 | Ocean acidification, Global Ocean circulation, Upwelling and circulation patterns, El Nino and Southern Oscillation, |
| | | | 21-24 | IPCC and its reports, UNFCCC, Kyoto Protocol, and Politics of climate change. |
| | | | 25-28 | Forecasting systems: Fisheries forecasts – Interpretation and use of ocean thermal structure; Fisheries forecasting system in India and other countries: Application of Remote sensing and GIS in fisheries; Application of echosounders and SONAR; Potential fishing zones. |
| | | | 29-32 | Factors affecting marine fisheries. Adaptation and mitigation measures for Climate change; Vulnerability assessment; Climate-resilient |

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| | | | | aquaculture; Climate-smart villages |

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| **3** | **FE.416** | **1+1=2** | | **RESPONSIBLE AND SUSTAINABLE FISHING METHODS** |
| | | | ***THEORY*** | |
| | | | 1 | CCRF: Scope and objectives of FAO Code of conduct for Responsible Fisheries, Articlesof CCRF – Description of the code, Analysis of marine catch data (present and past); analysis of CCRF concept. |
| | | | 2 | Definition of sustainability, Rules and regulations for sustainable fishing, Properties of a sustainable fishery, Present scenario and problems of sustainable fishing, Trends in global and Indian fishery, Environmental defects. |
| | | | 3 | By-catch: Elaboration of Article 8 – Fishing operations; By-catch and discards – Definitions, By-catch estimation methods, by-catch reduction devices, turtle excluder devices, Finfish and shrimp excluder devices. |
| | | | 4 | Selective fishing gear and practices: Selectivity of trawls, gill nets and lines – Environmentally friendly fishing methods and fishing gears – Energy conservation and resource enhancement. |
| | | | 5 | Fish Aggregation Devices (FADs and Artificial reefs): Objectives, Types of FADs and artificial reefs; Design and construction of FADs and artificial reefs; Energy optimization in fisheries – Methods of energy conservation in fish harvesting. |
| | | | 6 | Remote Sensing and PFZ: Application of Remote sensing, PFZ and GIS in fisheries. |
| | | | 7 | IUU - Illegal, Unregulated and Unreported fishing methods; Destructive and prohibited fishing systems and practices. |
| | | | 8 | Effect of fishing on non-target species. |
| | | | 9 | Impacts of unsustainable fishing: Habitat degradation due to bottom trawling, purse seining, Habitat modification, changing the ecosystem balance, Climate change, Ocean pollution, Disease and toxin. |
| | | | 10 | Fisheries management, Ecosystem-based fisheries, |
| | | | 11 | Marine protected area, Laws and treaties, |
| | | | 12 | Conservation methods issues and implications for biodiversity. |
| | | | 13 | Remediation for sustainable fishery, Fisheries management, Ecosystem-based fisheries, |
| | | | 15 | Marine protected area, Laws and treaties, Awareness |

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| | | | | campaigns, Sustainable fishing gears and devices, designing of eco-friendly long line, |
| | | | 16 | Eco-friendly gillnet, Eco-friendly trawl net, Techniques reducing the risk of unsustainability, Eco-friendly fishing methods and gears. |
| | | | ***PRACTICAL*** | |
| | | | 1 | Study of design and operation of BRDs |
| | | | 2 | Study of design and operation of TEDs. |
| | | | 3 | Preparation of document listing and prohibited fishing practices. |
| | | | 4 | Compilation of package of practices for energy conservation. |
| | | | 5 | Designing of eco-friendly fishing devices, |
| | | | 6 | Designing of square mesh cod end, |
| | | | 7 | Designing of traps with escape vents, |
| | | | 8 | designing of longline with circular hooks. |
| | | | 9 | Interpretation of SST charts |
| | | | 10 | Interpretation of Ocean colour charts. |
| | | | 11 | Study of Potential Fishing Zone(PFZ) maps. |
| | | | 12 | Problems on fishing gear selectivity. |
| | | | 13 | Problems on fishing gear selectivity. |
| | | | 14 | Problems on fishing gear selectivity. |
| | | | 15 | Studies on impact of various fishing gears on the environment |
| | | | 16 | Studies on impact of various fishing gears on the biodiversity. |

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| **4** | **FEES.416** | **1+1=2** | | **ICT IN FISHERIES** |
| | | | ***THEORY*** | |
| | | | 1 | ICTs – meaning, concepts, roles and initiatives, basics of ICTs, Global and National status |
| | | | 2 | Types and functions of ICTs, Meaning of e-Governance, e-learning, m-Learning, Advantages and Limitations of ICTs |
| | | | 3 | Knowledge management: Meaning, Approaches and Tools, Role of ICTs in Agricultural Knowledge Management, |
| | | | 4 | e-Extension, overview on Global and national e-Extension initiatives, Inventory of e-Extension initiatives in Agriculture and allied sectors from Central and State governments, ICAR, SAUs, private sector and NGOs in India |

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| | | | 5 | ICT applications: Knowledge centres (tele centres), CSC, Digital kiosks, Web portals, Community radio, Internet radio, Kisan call centres, Mobile based applications, INCOIS-PFZ advisories |
| | | | 6 | Self-learning CDs on Package of practices, Augmented Learning, Virtual Learning, social media, Market Intelligence and Information Systems-e-NAM, Agmarknet, etc. |
| | | | 7 | Expert System/ Decision Support System/ Management Information Systems, Farm Health Management and Intelligence System for Plant /Animal/ Soil Health, Fishery, Water, Weather, etc., National e-Governance Plan in Agriculture (NeGP-A). |
| | | | 8 | Networks and policies: Global and regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Coursera, EduEx, etc.); Digital networks among extension personnel |
| | | | 9 | Farmer Producers Organisations (FPOs) / SHGs/ Farmers Groups, |
| | | | 10 | Video conference, Live streaming and Webinars |
| | | | 11 | Types and functions of social media applications, Guidelines for preparing social media content, Engaging audience, Data- analytics and Info graphics |
| | | | 12 | Smart technologies for extension: Open technology computing facilities, System for data analytics/ mining/ modelling/ Development of Agricultural simulations |
| | | | 13 | Remote Sensing, GIS, GPS, Information Utility (AIU) |
| | | | 14 | Disruptive technologies Analysis |
| | | | 15 | Internet of Things (IoTs), Drones, Artificial intelligence (AI) |
| | | | 16 | Blockchain technology, Social media and Big Data analytics for extension |
| | | | ***PRACTICAL*** | |
| | | | 1 | Content and client engagement analysis. |
| | | | 2-5 | Case studies and exercises on ICT-based |

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| | | | | interventions in fisheries and agriculture. |
| | | | 6 | Designing extension content for ICTs |
| | | | 7-8 | Creating and designing web portals, blogs, social media pages |
| | | | 9 | Development and use of online and offline e-learning modules in fisheries. |
| | | | 10 | Live streaming extension programs and organizing webinars. |
| | | | 11 | Visit to KCC |
| | | | 12 | Exercises on developing mobile-based applications. |
| | | | 13 | Developing social media pages for disseminating fisheries related information. |
| | | | 14 | Writing for digital media. |
| | | | 15 | Developing video content related to fisheries. |
| | | | 16 | Conducting exercise on remote sensing and GIS |

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| **5** | **AEM.412** | **1+1=2** | | **AQUATIC MICROBIOLOGY** |
| | | | ***THEORY*** | |
| | | | 1-2 | Distribution and classification: Microbial community in freshwater; Estuarine and marine environment (types and abundance). |
| | | | 3 | Factors affecting microbial growth and abundance. |
| | | | 4 | Microbial interaction: Microbial degradation of persistent organic pollutants (POPs). |
| | | | 5-6 | Microorganisms and public health: Water-borne pathogens of public health importance - Protozoans, bacteria, entero-viruses. |
| | | | 7 | Microbial toxins; Algal toxins. |
| | | | 8 | Disinfection methods; Microbial standards for different water uses. |
| | | | 9-11 | Principles and applications of bioprocesses: Bioremediation, Biofertilization, Biofilms, Biofloc, Probiotics, Bio-leaching, Bio-corrosion, Bio-fouling. |
| | | | 12-13 | Microorganisms as Bio indicators and Biosensors. |
| | | | 14-15 | Methods of assessing microbial biomass production; Bioprospecting: Current practices in bioprospecting and biopiracy. |
| | | | 16 | Microbial metabolites and its industrial application. |
| | | | ***PRACTICAL:*** | |
| | | | 1-5 | Isolation, identification and enumeration of algae and bacteria from polluted aquatic habitats. |
| | | | 6-9 | Maintenance of algal and bacterial cultures. |

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| | | | 10-11 | Microbial sensitivity testing. |
| | | | 12-14 | Bio-activity testing. |
| | | | 15-16 | Disinfection methods. |

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| **6** | **FE.417** | **1+1=2** | | **GIS AND REMOTE SENSING IN FISHERIES** |
| | | | ***THEORY*** | |
| | | | 1 | Aerial Photography: Basics of photography-terminologies- Photogrammetry - Stereoscopy - Principal points - Parallax and its measurement, Colours - Composite colour images. |
| | | | 2 | Remote Sensing - Electromagnetic Spectrum - Radiation |
| | | | 3 | laws - Interaction with atmosphere and surfaces, Spectral reflectance of earth materials and vegetation, |
| | | | 4 | Satellite Remote Sensing - Resolution - Scanning - Sensors, Land Observation Satellites - Visual image interpretation. |
| | | | 5 | Image and Data: Digital image processing, Image rectification and Image enhancement - Filtering - Band rationing, Image classification - Supervised and unsupervised classification, |
| | | | 6 | Remote sensing application in soil and water conservation. |
| | | | 7 | GIS - Types, raster, vector, Database management systems, Data types. |
| | | | 8 | Spatial - non-spatial, Spatial data models, Spatial referencing. |
| | | | 9 | Map projections, Data input, Editing, Encoding. |
| | | | 10 | Raster data analysis, Vector data analysis |
| | | | 11 | Satellite Application: NOAA and IRS Satellites for Ocean and Fisheries studies. |
| | | | 12 | Digital image processing and interpretation |
| | | | 13 | Application of remote sensing and GIS to fisheries and aquaculture planning and development. |
| | | | 15 | PFZ- Basics and application |
| | | | 16 | Validation of PFZ data- INCOIS- Data Dissemination. |
| | | | **PRACTICAL** | |
| | | | 1 | Study of satellite information. |
| | | | 2 | Interpretation of satellite pictures for resource management. |
| | | | 3 | Interpretation of satellite pictures for resource management. |
| | | | 4 | Casestudies on remote sensing |

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| | | | 5 | Casestudies on GIS applications. |
| | | | 6 | Development of GIS with local parameters related to fisheries. |
| | | | 7 | Development of GIS with local parameters related to fisheries. |
| | | | 8 | INCOIS data processing |
| | | | 9 | INCOIS data interpretation. |
| | | | 10 | Collection of INCOIS data. |
| | | | 11 | Validation of INCOIS data. |
| | | | 12 | Collection of PFZ data. |
| | | | 13 | Validation of PFZ data. |
| | | | 14 | INCOIS data dissemination methods among coastal fishermen. |
| | | | 15 | INCOIS data dissemination methods among coastal fishermen. |
| | | | 16 | Survey of effectivenessand usefulness of PFZ data. |

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| **7** | **FPT.418** | **1+1=2** | | **PRINCIPLES AND TECHNIQUES OF SEAFOOD ANALYSIS** |
| | | | ***THEORY*** | |
| | | | 1-3 | Separation of molecules: General principles of separation of micro and macro-molecules, Selection of appropriate tools for analysis of fish samples, Outlines of common techniques involved in biochemical analysis. |
| | | | 4-5 | Filtration and centrifugation techniques: Different types of filtrations, Types of filters and means of using them; |
| | | | 6-7 | Types of centrifugations (preparative and analytical), concept of Svedberg unit, Selecting appropriate rotor, Relative centrifugal force. |
| | | | 8-10 | Viscoelastic properties, Rheology, Tribology, TPA; IR and FTIR spectrophotometry, Spectro-fluorimetry, ICP, Atomic absorption mass spectrometry, Tandem MS/MS. |
| | | | 11 | Microscopy: Fluorescence microscopy, SEM, TEM, XRD. |
| | | | 12 | Electrophoresis: General principles, types (native, denatured PAGE, 2D). |
| | | | 13-16 | Chromatographic techniques; General principle, Types of chromatography: adsorption, partition, ion-exchange, molecular sieve, affinity, liquid and gas chromatography (GC), thin layer chromatography, HPLC, GCMS, LCMSMS. |
| | | | ***PRACTICAL*** | |

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| | | | 1-3 | Characterization of proteins based on solubility: sarcoplasmic, myofibrillar, and stroma; Estimation of proteins - Biuret techniques, Lowry techniques, |
| | | | 4-6 | Dye binding technique and electrophoretic techniques. |
| | | | 7-8 | Amino acid analysis by HPLC. |
| | | | 9-11 | Fatty acid analysis by GC MS, Minerals and heavy metals by Atomic Absorption spectroscopy. |
| | | | 12 | Texture analysis by TPA. |
| | | | 13 | HPLC- determination of histamine. |
| | | | 14-16 | Demonstration of GC-MS-MS. |

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| **8** | **FPT.419** | **1+1=2** | | **TRADE REGULATIONS, CERTIFICATION AND DOCUMENTATION IN EXPORT OF FISH AND FISHERY PRODUCTS** |
| | | | ***THEORY*** | |
| | | | 1-2 | Trade policy and Legislation on labelling and other standards: Foreign Trade Policy of Fish and Fishery Products in Indian context and world context, |
| | | | 3-4 | Labelling requirements of Fish and Fishery products stipulated by National and International Organizations. |
| | | | 5 | Regulations: Export documentation- certificates of origin. |
| | | | 6-7 | Other certificates for Shipment of specific goods, Export licenses; Import regulations, SPS-TBT agreement. |
| | | | 8-9 | Export Certification systems: Consignment-wise, in process Quality, |
| | | | 9-10 | Self-Certification, Food safety management system, Pre-shipment inspection, |
| | | | 10-11 | Voluntary food certification scheme, Certificate for export (CFE), Health certificate. |
| | | | 12 | Other certification, |
| | | | 13-14 | Traceability issues for farm reared and wild aquatic products; |
| | | | 15-16 | Dealing with returned consignments; foreign trade regulations in India. |
| | | | ***PRACTICAL*** | |
| | | | 1-3 | Documentation protocol for approval of fishing vessel, processing unit and technologist in processing plants. |
| | | | 4-6 | Labelling codes for Traceability of products in Export trade. |
| | | | 7-8 | Preparation of BOL and LC. |

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| | | | 9-12 | Preparation of documents for seafood export to different destinations. |
| | | | 13-16 | Study of documents on customs and port procedures for seafood export and import. |

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| **9** | **FEES.417** | **1+1=2** | | **MARKETING INTELLIGENCE AND BUSINESS ANALYSIS** |
| | | | ***THEORY*** | |
| | | | 1 | Research methodology: The role of marketing intelligence in the firm, The process of marketing research, The difference between exploratory and confirmatory research |
| | | | 2 | Secondary and primary data, Qualitative and quantitative research methodologies, Sampling theory. |
| | | | 3 | Requirements in business analysis: Management, Communication, Tracing, Configuration and change management, quality assurance,. |
| | | | 4 | Development, Elicitation including stakeholders and/or product requirements development, Specification |
| | | | 5 | Business analytics: Business Analysis, Internal analysis, External analysis, Business need definition, Gap analysis, Solution proposal (including feasibility analysis) |
| | | | 6 | Solution delivery or maintenance program/project initiation- Business process definition, Business goals, Business needs, Business requirements, Limitations and assumptions. |
| | | | 7 | Modelling and forecasting: Solution modelling, validation and verification, Solution evaluation and optimization, |
| | | | 8 | Assessing the solution options (proposals), Evaluating performance of the solution, Solution/business process optimization, Model Volatility with ARCH and GARCH for Time Series Forecasting. |
| | | | 9 | Marketing research: Definitions of the various methodological concepts, various steps involved in designing a research plan. |
| | | | 10 | Data collection methods; Characteristics, Structure, Sources, Value, and use of Big Data. |
| | | | 11 | The relationship between digital analytics and inbound marketing strategies |
| | | | 12 | Consumer information and measurement services, Rules for designing a questionnaire |

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| | | | 13 | Data analysis in marketing research: Data sources for assessing consumer preferences, firm performance, and market condition. |
| | | | 14 | Competition analyze enterprise data, especially for purposes of segmentation, targeting, positioning, and evaluating consumer value. |
| | | | 15 | Process of organizing, writing, framing, and refining analytics reports. |
| | | | 16 | Delivering effective presentations, and aligning analytic results with stakeholder needs and preferences. |
| | | | ***PRACTICAL*** | |
| | | | 1-2 | Marketing Research – ethics, standards and issues. |
| | | | 3-5 | Utilization of Secondary Data Resources for Customer Segmentation Pricing and Elasticity. |
| | | | 5-7 | Linear Regression, Basics; Using Linear Regression to Forecast. |
| | | | 8-10 | Conjoint Analysis; Digital Marketing Metrics Customer Lifetime Value; Cluster Analysis. |
| | | | 11-12 | Finding and interpreting secondary data. |
| | | | 13-14 | Suggesting a methodology for fisheries marketing research. |
| | | | 15-16 | Tools and concepts of data visualization. |

| **VIII Semester (Student READY)** | | | | |
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| Student opting for 4-year B. F. Sc. A Student READY (Students Entrepreneurship Awareness Development Yojana) Program on In-plant /Industry Attachment/Rural Fisheries Work Experience (RFWE) Program/ Experiential Learning Program (ELP) / Project Work & Seminar will be undertaken as follows. | | | | |
| 1. | READY.421 | In-plant/Industry Attachment | 5(0+5) | **20(0+20)** |
| 2. | READY.422 | Rural Fisheries Work Experience (RFWE) Program | 6(0+6) | |
| 3. | READY.423 | Experiential Learning Program (ELP) | 6(0+6) | |
| 4. | READY.424 | Project Work & Seminar | 3(0+3) | |