

Semester – I

Unit – 1: Principles of Aquaculture:

(SBVOC-IAF-V-101)

Credit : 5 (MARKS : 80)

Theory:

1. Basics of aquaculture-definition and scope.
2. Present global and national scenario.
3. Overview of national and international aquaculture systems. Systems of aquaculture - pond culture, cage culture, running water culture, zero water exchange system, raceway .
4. Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water and inland saline water.
5. Principles of organic aquaculture, sewage fed aquaculture.
6. Pre-stocking and post stocking pond management.
7. Criteria for selection of candidate species for aquaculture. Major candidate species for aquaculture: freshwater, brackish-water and marine.
8. Monoculture, polyculture and integrated culture systems.
9. Water and soil quality in relation to fish production and estimation of productivity. Physical, chemical and biological factors affecting productivity of ponds. Nutrition, health management and economics.
10. Introduction of Exotic Fish Species in India (Teach in brief definition, a few examples and possible impact
11. Predatory and Weed Fishes and its Management (brief idea).
12. Aquatic insect management.
13. Weed management in Pond

Practical:

1. Practices on pre-stocking and post stocking management.
2. Identification of Predatory and Weed Fishes.
3. Identification of Aquatic Insect
4. Identification of Aquatic weeds, preparation of herbarium sheets.

Field Visit:

Visit to any Krishi Vigyan Kendra or fish farm to take detailed training about fish farming and report submission.

Unit – 2: Taxonomy of Fish and Shell Fish

(SBVOC-IAF-V-102)

Credit :4 (MARKS : 70)

Theory:

1. Principles of taxonomy, nomenclature, types.
2. Classification and interrelationships, Criteria for generic and specific identification.
3. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes.
4. Commercially important freshwater and marine fishes of India and their morphological characteristics.
5. Study of external morphology and meristic characteristics of Crustacea and Mollusca.
6. Classification of Crustacea and Mollusca up to the level of species with examples of commercially important species.

Practical:

1. Collection, preservation and identification of commercially important fish organisms.

2. Fin formula calculation.
3. Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats.
4. Field visits for collection and identification of commercially important shellfishes.

Unit – 3: Fish and Shell Fish Biology:

(SBVOC-IAF-V-103)

Credit : 5 (MARKS : 80)

Theory:

1. Study of fish for their external morphology and diagnostic features, Study of general morphology of a typical elasmobranch and a typical teleost and difference between them.
2. Body shapes (types and advantages), skin (structure, components, significance), coloration and its significance in fishes, scales (structure, types, significance), mouth (types, adaptations, importance), jaws (structure), fins and fin rays (structure, types and function), swim bladder (structure and function), Weberian apparatus (structure and function), sense organs (eyes, lateral line organ, barbells, chemoreceptors), special organs (electric organ and light organ).
3. Internal anatomy of fish (teleost) – digestive system and associated structure, respiratory and accessory respiratory organs, heart and circulatory system, reproductive system, excretory system.
4. Study of shell fish for their external morphology and diagnostic features, Study of general morphology of shellfish - External character of prawn, crab, lobster, bivalve, gastropod and cephalopod.
5. Internal anatomy of prawn, crab, lobster, bivalve, gastropod and cephalopod. Studies on Digestive system and Associated digestive glands. Circulatory system. Respiratory system. Nervous system. Urino-genital system. Endocrine system, Circulatory, Skeletal systems and Sensory organs.
6. Breeding and feeding habits of prawn, crab, lobster, bivalve, gastropod and cephalopod.

Practical:

1. Dissection of fish: internal anatomical structures – urinogenital systems, digestive systems, accessory respiratory organ.
2. Estimation of RLG and gut content analysis.
3. Estimation of fecundity.
4. Dissection of different external parts of shell fishes and their identification.
5. Dissection of internal anatomy of prawns and crabs.

Unit – 4: Information & Communication Technology

(SBVOC-IAF-V-104)

Credit : 4 (MARKS : 70)

Theory:

1. Computer fundamentals, computer basics, input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts.
2. WINDOWS and LINUX Operating Systems; Internet and World Wide Web, HTML and IP; Introduction to MS Office – Word, Excel, Power Point. Audio visual aids.

Practical:

1. Exercises on binary number system, algorithm and flow chart

2. MS Word; MS Excel; MS Power Point;
3. Internet applications: Web Browsing, Creation and operation of E-Mail account; Analysis of fisheries data using MS Excel.
4. Handling of audio visual equipment- tape recorder, public address system, overhead projector, LCD projector.

Project work : Planning, preparation, presentation of posters, charts, overhead transparencies and slides
Organization of an audio visual programme.

Semester – II

Unit – 5: Soil and Water Quality Management

(SBVOC-IAF-V-201)

Credit : 5 (MARKS : 80)

Theory:

1. Standard solutions , dilute solutions units of concentration: standard curve; monograph.
2. Chemistry of water; the water molecule, properties of pure water and sea water.
3. Composition of surface water, ground water and Sea water.
4. Dissolved gasses. Factors affecting natural waters. Acid, base, salts; Hydrogen ions, concept of pH and buffer.
5. Water quality criteria/ requirements forAquaculture.
6. Soil characteristics: origin and nature of soils. Physical properties of soil; soil colour. Soil texture, soil structure, pore size, bulk density, water holding capacity, soil types and their distribution.
7. Soil chemistry: soil colloids, cation exchange, organicCarbon, Carbon – Nitrogen ratio, soil fertility, soil reaction: Acidity, Alkalinity, Conductivity, Redox potential. Submersed soils, wet lands, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphatesoils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soilsamples. Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil quality criteria/ requirements foraquaculture. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum, environmental ameliorative: chlorination, deodorizers, bacterial formulation.

Practical:

1. Water analysis:

- a. Measurement of temperature,
- b. Turbidity, Determination of pH and EC.
- c. Total dissolved solids and total solids.
- d. Determination of salinity and chlorinity
- e. Determination of carbonates and bicarbonates
- f. Redox potential,
- g. Dissolved oxygen (DO),
- h. Dissolved free CO₂.
- i. Determination of total alkalinity,
- j. Total hardness.

- k. Determination of total ammoniacal nitrogen (TAN), nitrite nitrogen (NO₂-N) and nitrate nitrogen (NO₃-N).
 - l. Determination of phosphorus
- 2. Soil analysis:**
- a. Determination of soil texture,
 - b. Soil pH and conductivity,
 - c. Soil available nitrogen,
 - d. Available phosphorus,
 - e. Organic carbon.

Unit – 6: Capture fisheries resources:

(SBVOC-IAF-V-202)

Credit : 4 (MARKS : 70)

Theory:

1. Importance of capture fisheries of the world, present yield and estimates of potential. Inland capture fishery resources of India, their problems and prospects – rivers, reservoirs, floodplain, estuaries, mangroves and lakes.
2. Marine capture fishery resources of India, their problems and prospects – Zonation of marine environment, inshore, offshore and demersal resources. Problems of offshore fisheries, Concept of EEZ, MSY, overfishing and conservation, Close season, biodiversity management, sanctuaries, bycatch, mesh size regulations, catch per unit effort (CPEU), fishing fleet, banned species.
3. International fisheries commissions, Indian fisheries act, Environmental act, Concept of marine zonation.
4. Fishing crafts and gears identification .
5. Management and operation of different fishing equipment, turtle excluder device, fish finder, G.P.S., net hauler .
6. Remote sensing and its application in marine fisheries.

Practical:

1. Introduction to GPS, Mapping.

Field Visit:

1. Visit to any coastal area markets of fish markets to identify the fishes and submission of report and report submission.

Unit – 7: Fisheries Economics:

(SBVOC-IAF-V-203)

Credit : 5 (MARKS : 80)

Theory:

1. Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production etc.
2. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, consumer's surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns – breakeven analysis of fish production system; factors of production, marginal cost and return, economies of scale and scope, revenue, profit maximization, farm planning and budgeting. Preparation of enterprise budget for integrated fish farming.

3. Role of fishermen in Indian Economy, role of women in Indian fisheries, Women employment, Fish marketing and selling, Cooperative laws. Role of cooperative society in marine fisheries sectors, role of NGOs and SHGs in fisheries

Practical:

1. Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products, calculation of price.
2. Contribution of fisheries to Indian Agriculture and total GDP – atrend analysis. Pattern and Performance of India’s Seafood Exports; Case studies onproduct and market diversification. Case studies on competitiveness of Indian fish andfish products.
3. Field study and report submission to any Cooperative Society or Self-help group related to fish or fishery by product production

Unit – 8: Bio Securities: [\(SBVOC-IAF-V-204\)](#)

Credit : 3

Semester – III

Unit – 9: Fundamentals of Microbiology:

[\(SBVOC-IAF-VI-301\)](#)

Credit : 4 (MARKS : 70)

Theory:

1. History of microbiology, microbial world and their structural characters.
2. Classification of bacteria and fungi- molecular methods in taxonomy, ribosomal RNA sequences and evolutionary relationships.
3. Microscopy – bright-field, fluorescence, phase-contrast, dark ground and electron microscopy.
4. Staining techniques - chemistry and various types – Sterilization – principles and various physical and chemical methods.
5. Nutritional requirements of microorganisms – general growth media, differential media, selective media. Isolation, enumeration, preservation and maintenance of cultures - growth curve.
6. Routine tests for identification of bacteria - morphological, cultural, biochemical and serological. Anaerobic bacteria - methods of anaerobiosis. Basics of mycological techniques. Introduction to molecular techniques in microbiology.

Practical:

1. Microscopic techniques & Micrometry,
2. Staining techniques, isolation, enumeration and identification of microorganisms, serological techniques, Culture of bacteria, isolation.

Field Visit:Field training to any microbiological laboratory (Govt. or Private Sector) and report submission.

Unit – 10: Food microbiology:

[\(SBVOC-IAF-VI-302\)](#)

Credit : 5 (MARKS : 80)

Theory:

1. Common Food borne Bacteria, Moulds and yeasts. Role, and Significance of Microorganisms in Foods. Methods for detection of microorganisms in food: freshwater fish, sea foods.
2. Food Preservation &Principles of Quality Control - Chemicals, Antibiotics, Bacteriocin. Applications of Probiotics and prebiotics.
3. Food spoilage and food borne diseases - Common food borne pathogens, Entero pathogens and diseases: Applications of food microbiology: Microorganisms in Food Fermentation.

4. Detection of microbial spoilage in canned foods.
5. Hazard analysis and critical control path (HACCP) – Overview of HACCP, advantages and benefits of HACCP, principles and steps of HACCP, evaluation of HACCP procedures,
6. Basic concept of good manufacturing practice (GMP) – definitions, requirements and historical background, categories of GMP, quality assurance, quality management, principles of documentation in GMP.
7. Sanitation standard Operating Procedures – principles, definitions, pre operational and operational SSOPs, Actions and steps of SSOPs in fish processing industries.

Practical:

1. Culture and identification of bacteria from fresh fish specimen collected from markets, standard plate count.
2. Outline different HACCP based systems in different fish processing unit including CODEX and ISO 22000.
3. Outline relevant codes of practice and industrial guides.
4. Microbial analysis in industries of fish products.

Field Visit: Visit to any microbiological laboratory of central government or state government institutions or any private industry based laboratory for microbiological training and report submission.

Unit – 11: Environmental Microbiology:

(SBVOC-IAF-VI-303)

Credit : 5 (MARKS : 80)

Theory:

1. Microbial communities in the aquatic environment, kinetics of microbial population, biofilms, microbial interactions – symbiosis, antagonism and commensalisms, biogeochemical cycles.
2. Pollution – nature and types, their effects on living organisms. Water pollution microbial changes induced by inorganic and organic pollutants, industrial effluents and domestic sewage. Water-borne pathogens – faecal contamination; enteroviruses. Standards for various types of water, conventional wastes and their treatment – Biological pollution – algal blooms and their effect on fish production, biological and chemical control of algal bloom.
3. Metals as pollutants – accumulation of mercury, cadmium, lead, etc. in fishes, microbial conversion of mercury. Microbial pollution in industries-corrosion of iron, acid-mine drainage, cooling systems etc.

Practical:

1. Microbial pollution of water, detection and characterization of different indicator and pathogenic organisms such as *S. aureus*, *E. coli*, *V. cholerae*, *Salmonella*, *Shigella*, etc., by conventional and rapid methods,
2. Antibiotics testing
Chloramphenicol, nitrofevron, ozone testing in particular
Post larvae buy elisa testing machine with kits (mandatory practical)

Unit – 12: Aquatic Animal Health:

(SBVOC-IAF-VI-304)

Credit : 4 (MARKS : 70)

Theory:

1. Introduction to the pathogenic diseases of fish and shell-fish organisms – viral, bacterial, fungal and parasitic, prophylactic and therapeutic measurement of fish diseases.

- Immune system in fish. Lymphoid tissues and cellular components of the immune system. Defence mechanisms in fishes against pathogenic microorganisms – specific and non-specific defences. Mechanisms of disease production.
- Types of immune response-humoral and cellular and the interaction between the two, immunological tolerance and memory function, activation and interaction of T and B lymphocytes. T-cell receptors, immunoglobulins, theories of antibody production, monoclonal antibodies, antigen-antibody reactions, complement system.
- Major histo-compatibility complex. Vaccines for fishes. Techniques of vaccination. Host response and effect of environmental factors.
- Identification of the pathogens in fishes and shell-fish organisms, morphology.
- Introduction to the non-infectious fish and shell-fish diseases, nutritional and environmental diseases to the fish, different soil and water parameters related to fish health.
- Application of different chemicals, drugs, antibiotics, probiotics etc. to the fish pond, dosage calculation, preparation of healthy diets of the fish.
- Histopathological study of different organs in fish.

Practical:

- Examination of moribund fishes, sampling techniques of microbial investigation.
- Culture, identification and isolation of different disease causing agents in fish and shell-fish, Serological and molecular techniques for disease diagnosis.
- Preparation of histological slides of different organs in fishes.
- Field application of different chemicals and drugs to infected fish.

Semester – IV

Unit – 13: Food chemistry and Fish in Nutrition

(SBVOC-IAF-VI-401)

Credit : 4 (MARKS : 70)

Theory:

- Composition of food & nutritional value.
- Carbohydrates: Naturally occurring polysaccharides in foods, fibre in food and its role. Browning reactions- enzymatic and non-enzymatic. Glycolysis, gluconeogenesis, glycogenolysis, and glycogenesis.
- Biological oxidation, electron transport chain, P/O ratio; oxidative phosphorylation.
- Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturized proteins.
- Fish muscle proteins, chemical changes in muscle during contraction; Digestion and absorption of proteins; metabolism- amino acid pool; nitrogen balance; essential and non-essential amino acids; deamination; decarboxylation; metabolic fate of amino acids.
- Protein synthesis; Chemistry of taste, flavour and odour components in foods: flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish.
- Food additives - types and their chemical nature. Enzymes, vitamins and amino acids, emulsifiers and antimicrobial additives, sequestrates, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food.
- Assessment of quality of food by instrumental and chemical methods.
- Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility, chemical score. Role of fibre in human nutrition.

(Not in detail)

Practical:

1. Estimation of moisture, crude protein, fat, ash and carbohydrate in food sample.
2. Determination of energy value of foods. Estimation of glucose and salt content in foods.
3. Estimation of vitamins. Estimation of quality of fish from degraded products of protein and fat.

Unit – 14: Fish Nutrition:

(SBVOC-IAF-VI-402)

Credit : 4 (MARKS : 70)

Theory:

1. Nutritional requirements of cultivable fish and shellfish.
2. Feed formulation and manufacturing. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants.
3. Feed storage, use of preservatives and antioxidants.
4. Feed evaluation - feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value.
5. Feeding devices and methods. Non-conventional feed ingredients and anti-nutritional factors.
6. Digestive enzymes, feed digestibility. Factors affecting digestibility.

Practical:

1. Proximate composition analysis of feed ingredients and feeds.
2. Preparation of artificial feeds using locally available feed ingredients.
3. Determination of sinking rate and stability of feeds. Effect of storage on feed quality.
(very important)

Unit – 15: Fish Processing Techniques:

(SBVOC-IAF-VI-403)

Credit : 6 (MARKS : 90)

Theory:

1. Processing of fish by traditional methods – salting, sun drying, smoking, marinating and fermentation. Packaging and storage of salted and dried fish. Different types of spoilage in cured fish. Quality standard for salted and dry fish. Carcinogenic compound in wood and methods to remove them.
2. Icing and freezing of fish and its problems and prospects. Layout and construction of freezing plants, cold storage, contact plate freezer, immersion freezer, tunnel freezer, air blast freezer, air lock system, anti-room arrangements.
Individual quick freezing with branching/cooking : breaded and battered products.
3. Equipment commonly available in processing units. Different types of ice making machinery. Operation of various machinery used in freezing; canning and packaging. Special equipment for freeze-drying;
(flake ice, tube ice, plate ice, slurry ice) [contact plate freezer, blast freezer, tunnel freezer, nitrogen freezer, brine freezer]
irradiation and cryogenics; general maintenance of freezing plant, cold storage and ice plant. Ice manufacturing unit, marine refrigerating plant; methods of defrosting; insulating material. Special equipment for freeze-drying; irradiation and cryogenics; general maintenance of freezing plant, cold storage and ice plant.

Practical:

1. Preparation of salted fish, dried fish and smoked fish by different methods.

Field Visit:

1. Visit to fishing harbour to study about deck machinery and hull equipment. Operation and maintenance of ice making machinery, fish products machinery and packing machinery. Study on different types of gallows.
2. Visit to a fish processing unit to study the equipment used in different types of processing.

Unit – 16: Fish Products and By-products, Quality Assessment:**(SBVOC-IAF-VI-404)****Credit : 4 (MARKS : 70)****Theory:**

1. Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, fish protein concentrate and their incorporation to various products.(only definition)
2. Chitin, chitosan.
3. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. and imitation products. Value addition.

Practical:

1. Preparation of diversified and value-added fish products – fish finger, fish cutlet, fish ball, fish and prawn pickle, fermented fish sauce and marinade products
2. Quality assessment of salted, dried and smoked fish, iced and freeze fish.
3. Quality assessment of individual by-products and value-added products.
5. Quality Assessment of packaging, MAP. BIS specifications for plastics for food contact applications and other regulations

Semester – V**Unit – 17: Fundamentals of Genetics:****(SBVOC-IAF-VII-501)****Credit : 6 (MARKS : 100)****Theory:**

1. Historical development of genetics and physical basis of heredity; Mendelian principles: scope, limitation, probability of Mendelian inheritance.
2. Genetic variation: Causes and measurement; Chromosome theory of inheritance: genetic basis of determination of sex.
3. Chromosome manipulation: Ploidy induction, sex reversal, gynogenesis and androgenesis.
4. Modern concept of gene; DNA as genetic material, genetic code and protein synthesis, transfer and regulation of genetic information.
5. Mutation: natural and induced, mutagens fate of mutant allele in the population; Cross breeding and genetic drift.

Practical:

1. Practical demonstration of chromosome manipulations, Linkage and crossing over, ploidy induction;

Unit – 18: Population Genetics:**(SBVOC-IAF-VII-502)****Credit : 3 (MARKS : 50)****Theory:**

1. Genetics of population: Individual vs. population, genetic structure of random mating populations.
2. Hardy Weinberg principles: Test of equilibrium, application and properties of equilibrium populations;

3. Change in gene frequency under migration, mutation and selection;
4. Effect of small population on gene frequency.

Practical:

1. Exercises on various statistical procedures with emphasis on nonparametric distributions;
2. Estimation of effective population size,
3. Marking and tagging techniques of fish for migration and population study.
4. Maintenance of genetic stock

Unit – 19: Selection Genetics:

(SBVOC-IAF-VII-503)

Credit : 3 (MARKS : 50)

Theory:

1. Selection of species for breeding, scope, application, role of genetics in fish selection.
2. Inbreeding depression: causes and methods to overcome; Selection for threshold characters; Small stock and inbreeding effects;
3. Out breeding: crossbreeding, utilization of heterotic effects.
4. Hybridization and its effect on fish.
5. Monosex fish production techniques and its culture procedure.

Practical:

1. Method of selection of species for fish breeding.
2. Techniques of monosex fish production (Tilapia).
3. Methods of hybridization of fish.

Unit – 20: Fish and Non-Fish Breeding:

(SBVOC-IAF-VII-504)

Credit : 6 (MARKS : 100)

Theory:

1. Breeding habits of different fishes.
2. Brood stock transport and management;
3. Breeding techniques of Indian Major Carps, Exotic carps, Sea bass, Mulletts, cat fishes, commercially important shell fishes, crabs.
4. New generation drugs and its application on fisheries.
5. Hatchery, types of hatchery systems, hatchery operation of commercially important fishes and shellfishes.
6. Nursery rearing techniques of commercially important fishes and shellfishes.
7. Seed transport technique.
8. Collection of seeds from natural resources.

Practical:

1. Induced breeding techniques, collection and preparation of pituitary gland extract, dissection of fish head to collect pituitary glands, preservation of pituitary gland and extract for future use.
2. Dosage calculation of pituitary glands and synthetic hormones.
3. Injection procedure and stripping methods for induced spawning.
4. Eye stalk ablation of shellfish.
5. Visit to any fish breeding centre for training and report submission.

Semester – VI

Unit – 21: Aquaculture Engineering

(SBVOC-IAF-VII-601)

Credit : 4 (MARKS :70)

Theory:

1. Land survey, area calculation of plane surface of regular and irregular shape as applied to measurement of land.
2. Farm-types and objectives; Freshwater and coastal aquafarms. Preliminary survey, site selection, topography.
3. Soil – types, properties, classification, sampling methods and texture analysis.
4. Design and construction of ponds and dykes.
5. Tidal influences and maintenance; Effect of seepage and evaporation and their control.
6. Water budgeting.
7. Water distribution system –main feeder channel, drainage channel.
8. Water control structure – types of inlets and outlet and their construction.
9. Aerators –principles, classification and placement. Pumps - types, total head and horse power.
10. Filters – types and construction.

Bio Security

Practical:

1. Land survey – chain surveying, compass surveying, levelling, plane table surveying and contour surveying;
2. Computation of water intake and discharge.
3. Visit to any aquaculture farm and report submission.

Unit – 22: Fundamentals of Ornamental Fish Culture

(SBVOC-IAF-VII-602)

Credit : 5 (MARKS : 80)

Theory:

1. World trade of ornamental fish and export potential.
2. Different varieties of exotic and indigenous fishes.
3. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium.
4. Water quality management. Water filtration system – biological, mechanical and chemical. Types of filters.
5. Aquarium plants and their propagation methods.
6. Lighting and aeration. Aquarium accessories and decorative.
7. Breeding habits of ornamental fishes.
8. Breeding techniques and hatchery management of ornamental fishes.
9. Brood stock management.
10. Application of genetics and biotechnology for producing quality strains.
11. Care and maintenance of young fishes.

Practical:

1. Construction of all glass aquarium.
2. Identification of fresh and marine ornamental fishes.
3. Identification of aquarium plants.
4. Handling and management of aquarium accessories and equipment.
5. Visit to any ornamental fish farm and report submission.
6. Breeding of common aquarium fishes in home aquarium.

7. Visit to some ornamental fish traders to study aquarium fish breeding techniques.
8. Visit to any ornamental fish farm for training and report submission.

Unit – 23:Ornamental Fish Health Management:

(SBVOC-IAF-VII-603)

Credit : 5 (MARKS : 80)

Theory:

1. Common pathogenic diseases and their control.
2. Common nutritional diseases and their control.
3. Health related issues related to water parameters in aquarium and their control.
4. Preparation of aquarium fish feed for better health and growth.
5. Use of different chemicals, drugs for health management.
6. Aquarium fish feeds. Dry, wet and live feeds.
7. Regular maintenance of aquariums, tanks for better hygiene.
8. Culture of fish feed organisms.

Practical:

1. Identification of common aquarium fish diseases.
2. Identification of common aquarium fish pathogens.
3. Identification of live feed in aquariums, Culture technique of live feed.
4. Dosage calculation of different chemicals and drugs in ornamental fish health management.
5. Visit to any ornamental fish farm for training and report submission.

Unit – 24: Ornamental Fish Trade:

(SBVOC-IAF-VII-604)

Credit : 4 (MARKS : 70)

Theory:

1. Present status of ornamental fish trade in West Bengal, India and the World.
2. Prospect of ornamental fish trade for employment generation and rural development.
3. Management practices of ornamental fish farms.
4. Packaging and transportation techniques of ornamental fish.
5. Marketing technique and strategy for ornamental fish in West Bengal.

CHEMISTRY

Semester – I

(GVOC-V-102)

Credit : 3 (MARKS : 50)

Chemical Periodicity:

Classification of elements on the basis of electronic configuration:

Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

Bonding :

General characteristics of ionic compounds and covalent compounds. partial ionic character of covalent bonds, Fajan's rules. Hydrogen bonding and its effect on physical and chemical properties. Coordinate bonds and Coordination compounds: complex salts and double salts, Warner's theory of coordination, chelate complexes (preliminary idea)

Acids-bases and solvents:

Arrhenius theory. Strengths of acids and bases (elementary idea). Ionization of weak acids and bases in aqueous solutions, application of Ostwald's dilution law, ionization constants, ionic product of water, pH-scale, buffer solutions and their pH values, buffer actions; hydrolysis of salts. Acids, bases and buffers in biological system;.

Volumetric Analysis:

Primary and secondary standard substances, principles of acid-base, oxidation-reduction, and complexometric titrations; (Examples of acid-base, redox and metal-ion indicators).

Principles of estimation of mixtures of NaHCO_3 and Na_2CO_3 (by acidimetry); iron, (by redox titration); , calcium, magnesium (by complexometric EDTA titration). .

Semester – II

(GVOC-V-202)

Credit : 3 (MARKS : 50)

Conductivity :

Electrolytic conductance, specific conductance, equivalent conductance and molar conductance of electrolytic solutions (for strong and weak electrolytes).

EMF :

Electrode potential: Electrode potentials, Nernst Equation, reference electrodes: normal hydrogen electrode and calomel electrodes, Emf of electrochemical cells and its measurement, electrode potential series and its applications.

Estimation of Water Quality

1. Estimation of pH value (Electrometric Method)
2. Conductivity Estimation (Instrumental Method)
3. Total Solids Estimation (Total Solids; Total Dissolved Solids)
4. Hardness Estimation (EDTA Titration Method)

Basic organic chemistry I :

Inductive effect, resonance and resonance energy. Homolytic and heterolytic bond breaking, electrophiles and nucleophiles; carbocations, carbanions and radicals (only preliminary idea).

Principles of qualitative inorganic analysis :

Analytical reactions for the detection of nitrate, nitrite, halides, phosphate, arsenate, arsenite, sulphide, sulphate, carbonate.

Fe^{3+} , Ni^{2+} , Cu^{2+} , As^{3+} , Mn^{2+} , Importance of common-ion effect in the separation of Group II cations, and Group III cations.

Semester – III

(GVOC-V-302)

Credit : 3 (MARKS : 50)

Thermodynamics:

Definition of thermodynamic terms: Intensive and extensive variables, isolated, closed and open systems. Cyclic, reversible and irreversible processes.

First law of thermodynamics, internal energy (U) and enthalpy (H); relation between C_p and C_v (not detailed calculation), w , q , ΔU and ΔH for expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes including free expansion (detailed calculation not required).

Joule-Thomson Coefficient and inversion temperature (only preliminary idea).

Basic organic chemistry I :

Inductive effect, resonance and resonance energy. Homolytic and heterolytic bond breaking, electrophiles and nucleophiles; carbocations, carbanions and radicals (only preliminary idea).

Alkanes, alkenes and alkynes:

Synthesis and chemical reactivity of alkanes, general methods of synthesis of alkenes, electrophilic addition reaction, Markownikoff's addition, peroxide effect, ozonide formation,

Semester – IV

(GVOC-V-402)

Credit : 3 (MARKS : 50)

Application of First law of thermodynamics:

Standard state, standard enthalpy changes of physical and chemical transformations: fusion, sublimation, vaporization, solution, dilution, neutralization, ionization, Hess's law of constant heat summation. Kirchhoff's equation, relation between ΔH and ΔU of a reaction.

Spontaneous processes, heat engine, Carnot cycle and its efficiency, Second law of thermodynamics, Entropy (S) as a state function. Free energy: Gibbs function (G) and Helmholtz function (A), Gibbs-Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of a process.

Aldehydes and ketones:

Methods of synthesis, physical properties, Cannizzaro reaction, Aldol condensation,

Principles of organic qualitative analysis :

Reactions involving the detection of special elements N, S and Cl in an organic compound (only Lassaigne's test).

Reactions involving the detection of the following functional groups:

Aromatic primary amino group (Diazotization reaction); Nitro group (Mulliken Barker's test); Carboxylic acid group (reaction with NaHCO_3); Phenolic OH (FeCl_3 test);

Carbonyl (aldehyde and ketone) group (DNP Test, etc.).

Semester – V

(GVOC-V-505)

Credit : 3 (MARKS : 50)

Chemical equilibrium:

Chemical equilibria of homogeneous and heterogeneous systems; temperature, pressure and concentration dependence of equilibrium constants (K_p , K_c , K_x); Le Chatelier's principle of dynamic equilibrium.

Chemical kinetics and catalysis:

Order and molecularity of reactions, rate laws and rate equations for first order and second order reactions (differential and integrated forms only); zero order reactions (only idea). Temperature dependence of reaction rate, energy of activation.

Catalytic reactions:

Homogeneous and heterogeneous catalytic reactions, autocatalytic reactions, catalyst poisons, catalyst promoters (definition and typical examples)

Carboxylic acids and their derivatives:

Acidity of carboxylic acids and effects of substituents on acidity, chemical reactivity,

Colligative Properties:

Colligative properties of solution, Raoult's Law, relative lowering of vapour pressure, osmosis and osmotic pressure; elevation of boiling point and depression of freezing point of solvents

Colloids:

Colloids and crystalloids, classification of colloids. Properties of colloids:

Brownian motion, peptization, dialysis, . Protecting colloids, gold number, isoelectric points, coagulation of colloids by electrolytes, Schulze-Hardy rule

Semester – VI

(GVOC-V-605)

Credit : 3 (MARKS : 50)

Liquid state:

Physical properties of liquids and their measurements: surface tension and viscosity. , application to biomolecules

Aromatic Hydrocarbons:

Reactions of benzene, synthesis of aromatic compounds using nitration, halogenation, Friedel-Craft's reactions.

Organic compounds containing nitrogen:

Aromatic nitro compounds – reduction under different conditions. [acidic, neutral and alkaline]. Methods of synthesis of aliphatic amines, ; methods of synthesis of aromatic amines.

Diazotization and coupling reactions;

Synthetic applications of benzene diazonium salts. [Sandmeyer's reaction, preparation of nitro compounds, phenols, carboxylic acids and hydrocarbons thereby]

Phenols:

Synthesis, acidic character and chemical reactions of phenols, Kolbe reactions, Reimer-Tiemann reaction.

Spectrophotometry

Concept of electromagnetic radiations - UV, visible, IR.

Lambert-Beer's law - derivation & deviation; absorptivity, & working principle of spectrophotometer.

Extinction

co-efficient. Types of spectrophotometry

Estimation of Water Quality

1. Dissolved Oxygen Estimation(Winkler Method with azide modification)
2. BOD Estimation(Titrimetric Method)
3. COD Estimation
 - (a) Open Reflux Method
 - (b) Closed Reflux Method using COD Digester
4. Total Organic Carbon Estimation(Combustion-infrared method)
5. Phosphate Estimation(Stannous Chloride Method)
6. Nitrogen(Nitrate) Estimation
 - (a) UV Spectrophotometric Method
 - (b) Phenol Disulphonic Acid Method
7. Nitrogen(Nitrite)Estimation(Colorimetric Estimation)
8. Metal Estimation(Flame Atomic Absorption Spectrophotometry)
9. Iron Estimation(Phenanthroline method)
10. Preliminary Digestion for Metals(Microwave Digestion System)
11. Cyanide Estimation(Colorometric Method)

MICROBIOLOGY

Semester – I

(GVOC-V-103)

Credit : 3 (MARKS : 50)

Concept of Microbiology

Introduction – Definition, scope, and history of Microbiology. Notable contributions in the development of microbiology.

Microscopy

Simple, compound microscope, light & dark field microscope, Fluorescent microscope, electron and phase contrast microscopes –functions and applications- Resolving power, Numerical aperture.

Stains and Staining procedures

Dyes and stains: Types, Fixatives, Mordants, Decolorizers. Simple and differential staining. Special staining (Cell wall, Capsule, Spores & Flagella)

Carbohydrates

Definition, Classification, Structure and Biological role of -Monosaccharides, Disaccharides and Polysaccharide (Only Preliminary idea)

Amino acids & proteins

General structure and features of amino acids (emphasis on amphoteric nature) Classification by R-group, Uncommon amino acids, and their functions. Amphoteric molecule, Zwitterion, Isoelectric point. Peptides and proteins- Definition and general features and examples with the biological role. Primary, secondary, tertiary, quaternary structures of proteins- Brief outline

Semester – II

(GVOC-V-203)

Credit : 3 (MARKS : 50)

Lipids

Fatty acids as a basic component of lipids and their classification, nomenclature, storage lipids and structural lipids. Types of lipids with the general structure of each and examples.

Bacterial morphology and subcellular structures

Morphology of bacteria, Slime layer, Capsule, Cell wall, Ribosome, Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies, Exospores & Cysts, Endospore, Flagella, Pilus, Fimbriae, Plasmids and Episomes, Nuclear material, Bacterial Chromosome

Bacterial Growth

Growth phases – Generation time, Batch culture, Continuous culture, Synchronous culture (definition and brief description). Physical factors influencing growth.

Water Microbiology

Microbiological analysis of water (total count, indicative organism), B.O.D. & C.O.D. -determination and implication. Coliform test - detection of faecal and non-faecal coliform); IMViC test.

Semester – III

(GVOC-V-303)

Credit : 3 (MARKS : 50)

Air Microbiology

Different types of microorganisms in the air, aerosols, sampling techniques, airborne pathogens, techniques of room sterilization.

Soil Microbiology

Different microbial groups in soil, a method of study, Rhizosphere, Phyllosphere. Brief account of microbial interactions-(Symbiosis, Neutralism, Commensalism, Competition, Ammensalism, Parasitism, and Predation)

Control of Growth of Microbes

Sterilization, Disinfection, Antiseptic, Sanitizer, Germicide, Antimicrobial agent (definition, application & examples); physical and chemical methods of disinfection and sterilization (mode of action, applications). Chemotherapeutic agents - Antibiotics (examples and mode of action).

Medical microbiology

Normal Microbial Flora (normal) of the human body: Thoracic, Abdominal, Urogenital & Skin. Mechanism of Bacterial Pathogenicity: Entry, colonization, growth, mechanism of damage of host cell. Production of endo-and exo-toxins - definition and general properties.

Semester – IV

(GVOC-V-403)

Credit : 3 (MARKS : 50)

Replication

DNA Replication in Prokaryotes- DNA-Replication-Meselson-Stahl experiment as evidence for semiconservative replication; Mechanism of replication.

Transcription

Transcription in prokaryotes- Mechanisms (Initiation, elongation, termination); subunits of bacterial polymerases, functions, and domains responsible for activity, elongation process, mechanism of termination, -dependent and independent termination

Translation

Mechanism of translation in prokaryotes- phenomena of initiation, elongation, termination; description of factors involved in these processes; genetic code; the role of aminoacyl-tRNA synthetases.

Recombinant DNA technology

What is Recombinant DNA technology? Different tools used in genetic engineering (cloning, transformation, PCR, Sequencing) and their applications.

ZOOLOGY

Semester – I

(GVOC-V-104)

Credit : 3 (MARKS : 50)

- | Sl. No. | Topic |
|---------|--|
| 1. | Idea about general classification of animal kingdom with special reference to Porifera, Arthropoda, Mollusca, Chordate |
| 2. | Physio-chemical properties, types, structures [in brief] & functions of DNA & RNA. |
| 3. | Ecology & Ecosystem – definition, components, energy flow, food chain, food web, ecological pyramids. |
| 4. | Enzyme – classification & characteristics; mechanism of enzyme action; effects on enzymatic action [pH & temperature]. |
| 5. | Poultry : Duck & fowl – types of breeds, rearing & disease management. |

Semester – II

(GVOC-V-204)

Credit : 3 (MARKS : 50)

- | Sl. No. | Topic |
|---------|---|
| 1. | General structure & function of the following :
Respiratory pigments [Haemoglobin & Haemocyanin], Gills of Prawns. |
| 2. | Spermatogenesis & Oogenesis, Types of eggs |
| 3. | Population – definition & characteristics. |
| 4. | Community – definition & types. |
| 5. | Parasitism [definition & types] & other interspecific [symbiosis, commensalism & mutualism] interactions. |

Semester – III

(GVOC-V-304)

Credit : 3 (MARKS : 50)

- | Sl. No. | Topic |
|---------|---|
| 1. | General structure & function of the following :
Excretory system of prawn [Green gland].
Excretory system – pro., meso., & metanephric kidneys. Head kidney in fish & function. |
| 2. | Fertilization in sea-urchin & cleavages, Process of Gastrulation (Type: Frog). |
| 3. | Basic concept of Biodiversity, Biodiversity hot-spots. |
| 4. | Osmoconformers & Osmoregulators; osmoregulation in fishes. |
| 5. | Outline structure & classification of immunoglobulin, antigen-antibody reaction, basic principle of vaccination. |

Semester – IV

(GVOC-V-404)

Credit : 3 (MARKS : 50)

- | Sl. No. | Topic |
|---------|---|
| 1. | General structure & function of the following:
Reproductive system – asexual reproduction & its types, & sexual reproduction. |
| 2. | Basic idea of ecotoxicology & xenobiotics, concept of EIA |
| 3. | Conservation of wild-life – purpose & methods, concept of Biosphere Reserve, importance & strategies of wildlife conservation; conservation act & application. National Park & Wildlife Sanctuary, Animal cruelty & prevention act. |
| 4. | Schedule I of Wildlife Protection Act, 1972 & importance of schedules in conservation. |
| 5. | Basic concept of genetic engineering, gene cloning and gene manipulation. |

Semester – V

(GVOC-V-504)

Credit : 3 (MARKS : 50)

Sl. No.	Topic
1.	General structure & function of the following : .. Open circulatory system [Cockroach] & closed circulatory system with emphasis on single & double circuit heart.
2.	Classification of carbohydrate, protein & lipid.
3.	Concept of glycolysis, neo-glucogenesis [aerobic, anaerobic & fermentation].
4.	General characters of hormones, Naming & function of hormones secreted from Pituitary, Thyroid & Pancreas.
5.	Histology of Pituitary, Thyroid & Pancreas, Ovary & Testes

Semester – VI

(GVOC-V-604)

Credit : 3 (MARKS : 50)

Sl. No.	Topic
1.	General structure & function of the following : .. Integument – scales in fish.
2.	Definition of systematics & taxonomy, system of nomenclature
3.	Species as a unit of evolution [definition & types: biological, sibling & polytypic species].
4.	Anatomical & Physiological adaptations: Aquatic adaptation. Anadromous & catadromous migration in fish, Physiological changes and adjustment
5.	Pollution – air & water [sources of pollutants, effects & control measures].