REVISED UG SYLLABUS UNDER CBCS
(Implemented from Academic Year 2020-21)
PROGRAMME: FOUR YEAR B.Sc.

Domain Subject: **AQUACULTURE**
Skill Enhancement Courses (SECs) for Semester V, from 2022-23
(Syllabus-Curriculum)

Structure of SECs for Semester – V

(To choose One pair from the Three alternate pairs of SECs)

Univ. Code	Courses 6 & 7	Name of Course	Th. Hrs/ Wk	IE Marks	EE Marks	Credits	Prac. Hrs/ Wk	Marks	Credits
	6A	Soil and Water Quality Management	**3**	**25**	**75**	**3**	**3**	**50**	**2**
	7A	Ornamental Fish Culture	**3**	**25**	**75**	**3**	**3**	**50**	**2**

OR

	6B	Techniques for Aqua Lab	**3**	**25**	**75**	**3**	**3**	**50**	**2**
	7B	Fish Processing Technology	**3**	**25**	**75**	**3**	**3**	**50**	**2**

OR

	6C	Aquaculture Economics	**3**	**25**	**75**	**3**	**3**	**50**	**2**
	7C	Fish Microbiology and Quality Assurance	**3**	**25**	**75**	**3**	**3**	**50**	**2**

Note-1: For Semester-V, for the domain subject Aquaculture, any one of three pairs of SECs shall be chosen as courses 6 and 7, i.e., 6A & 7A or 6B & 7B or 6C & 7C. The pair shall not be broken (ABC allotment is random, not on any priority basis).

Note-2: *One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate field skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the field skills embedded in the syllabus citing related real field situations.*

Semester-Wise Revised Syllabus under CBCS, 2020-21

Course code:

Four-year B.Sc.

Domain Subject: **AQUACULTURE**

IV Year B.Sc.– Semester-V

Course 6A: **SOIL AND WATER QUALITY MANAGEMENT**

(Skill Enhancement Course (Elective), 05 Credits)

Max Marks: Theory: 100 + Practical: 50

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Know various types of soil and their properties
2. Monitor and manage optimum water quality parameters in fish/shrimp culture ponds
3. Maintain the soil and water quality by using required dose of lime, manures and fertilizers for optimum yields in culture ponds
4. Acquire knowledge on advanced technologies for improving water quality
5. Demonstrate skills related to chemical treatments for combating soil and water quality problems in aquaculture farms.

II. Syllabus: *(Total Hours: 90 including Teaching, Lab, Field Training and Unit tests, etc.)*

Unit-1: Soil quality (10h)

1. Soil types and their distribution. Physical and chemical properties of soil: Soil colour, texture, structure, pore space, bulk density, and water holding capacity; Conductivity, pH, redox potential, soil salinity, calcium carbonate, organic carbon, available nitrogen, available phosphorus, Carbon-Nitrogen ratio, organic matter and soil fertility.
2. Properties of water logged soils, methane and hydrogen sulphide formation. Problem soils: Saline soils, Alkali soils, Acid sulphate soils (ASS), and their reclamation.
3. Pond Seepage and its control. Soil quality criteria/requirements for aquaculture.

Unit-2: Water quality (10h)

1. Water quality parameters: Temperature, transparency, salinity, dissolved oxygen, carbondioxide, pH, alkalinity, hardness, conductivity, ammonia, nitrites, nitrates, orthophosphates and hydrogen sulphide; phytoplankton, zooplankton and benthos.
2. Role of aquatic microorganisms in carbon, nitrogen, phosphorus and sulphur cycles.
3. Water quality criteria for freshwater and brackishwater aquaculture.

Unit-3: Soil and Water amendments (10h)

1. Liming: Liming materials, effects of liming on pond ecosystem, liming rates for ponds, calculation of lime requirements and application of liming materials to ponds.
2. Manures and Fertilizers: Types of manures and fertilizers, primary nutrients, micronutrients, fertilizer grades, quantity and method of application; Biofertilizers.
3. Pond fertilization: Role of organic and inorganic fertilizers in aquaculture; Problems in ponds with indiscriminate fertilization.

Unit-4: Pond water management (10h)

1. Dial changes in dissolved oxygen concentration, oxygen depletion in ponds, Aeration, Water exchange, Bio-floc technology.
2. Water treatment, Water filtration devices, Waste water treatment practices, Waste discharge standards, Recirculatory aquaculture system (RAS).
3. Water quality management in freshwater carp culture; brackishwater shrimp culture; and hatcheries.

Unit-5: Pond treatments (10h)

1. Pond conditioners and Chemical treatments: Potassium permanganate, Hydrogen peroxide, Calcium hydroxide, Rotenone, Formalin and Malachite green. Methods of applying chemicals.
2. Reduction of pH; Control of turbidity, salinity, hardness and chlorides; Chlorine removal; Removal of toxic gases.
3. Control of algal blooms and aquatic weeds. Bioremediation: Soil and water probiotics for aquaculture ponds.

Practical Syllabus: Course 6A: **Soil and Water Quality Management**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Identify and handle various glassware, equipment and analytical instruments used for soil and water analyses.
2. Exhibit skills for preparing standard and working solutions for soil & water analyses.
3. Collect and analyze the physico-chemical and biological parameters of soil & water.
4. Calculate the dosages of lime and fertilizers required in ponds.
5. Apply the advanced techniques for quality improvement in ponds for better yields.

IV. Practical Syllabus:

1. Demonstration of laboratory glassware and equipment used in water and soil analysis.
2. Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colorimetry, Turbidimetry, Spectrophotometry (Vis, UV-Vis, Flame, Atomic Absorption Spectrophotometer (AAS)).
3. Solutions: Standard, and dilute solutions; units of concentration; standard curve.

Soil Analysis:

4. Collection and Processing of soil samples
5. Determination of Soil texture, pH, Redox potential and Conductivity.
6. Determination of Organic carbon, available nitrogen and available phosphorus.

Water Analysis:

7. Measurement of Temperature, Transparency, Turbidity, and Salinity of water.
8. Estimation of Dissolved oxygen, Free carbondioxide, Total alkalinity and Total hardness in water.
9. Estimation of ammonia, nitrites, nitrates, and orthophosphates.
10. Collection and identification of phytoplankton, zooplankton and benthos
11. Calculation of doses of lime and fertilizers for ponds
12. Design and fabrication of different filters.

V. References:

1. Boyd, C.E. (1982). Water Quality Management for Pond Fish Culture. Elsevier Sci. Publishing Co.
2. Boyd, C.E. and Tucker, C.S. (1992). Water Quality and Pond Soil Analyses for Aquaculture. Alabama Agricultural Experimental Station, Auburn University, USA.
3. Boyd, C.E. and Tucker, C.S. (2012). Pond aquaculture water quality management. Springer Science & Business Media.
4. ICAR. (2006). Hand Book of Fisheries and Aquaculture. ICAR.
5. MPEDA: Handbooks on culture of carp, shrimp, etc.
6. Training Manual on Recent advances in soil and water management in brackishwater aquaculture (2018). Saraswathy, R., Kumararaja, P., Lalitha, N., Suvana, S., Satheesha Avunje, Muralidhar, M. (Eds.), CIBA-TM Series –No.8 (2nd Ed), ICAR–Central Institute of Brackishwater Aquaculture, Chennai, India pp.137.
7. Boyd, C.E. (1995). Soil and water quality management in aquaculture ponds. INFOFISH international, *5*(95), 29-36.
8. Boyd, C.E. (1995). Bottom soils, sediment, and pond aquaculture. Springer Science & Business Media.
9. Pillay, T.V.R. and Kutty, M.N. (2005). Aquaculture- Principles and Practices. 2nd Ed. Blackwell
10. Dhevendaran, K. (2008). *Aquatic Microbiology,* Daya Publ. House.
11. APHA, AWWA, WPCF. (1998). Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association, American Water Works Association and Water Pollution Control Federation, Washington, D.C.
12. Chattopadhyay, G.N. (1998). Chemical analysis of Fish Pond Soil and Water. Daya Publishing House, Delhi.
13. Ramadhas, V. and R. Santhanam (1996). A Manual of Methods of Seawater and Sediment analysis. Fisheries College & Research Institute, Tuticorin.
14. Adhikari, S and Chatterjee, D.K. (2008). Management of Tropical Freshwater Ponds. Daya Publication.
15. Boyd, C.E. (2003). Guidelines for aquaculture effluent management at the farm-level. Aquaculture, 226(1-4), 101-112.
16. Harry, O. Buckman and Nyle, C. Brady. (1963). The Nature and Properties of Soils. The Macmillan Company, NewYork.
17. Rajagopalsamy, C.B.T. and Ramadhas, V. 2002. Nutrient Dynamics in Freshwater Fish Culture System. Daya Publication.
18. Stickney, R.R. (1979). Principles of Warm water Aquaculture. John-Willey & sons Inc.
19. Sverdrup, H.V., Johnson, M.W. and Fleming, R.H. *(*1942). The Oceans: their physics, chemistry and general biology. Prentice Hall, Inc. New York.
20. *Web resources suggested by the teacher concerned and the college librarian including reading material.*

VI. Co-Curricular Activities:

a) Mandatory: *(Training of students by teacher on field related skills: 15 hours)*

1. **For Teacher:** Training of students by teacher in laboratory and field for a total of 15 hours on handling and operation of glassware, equipment and instruments; preparation of standard and working solutions, and standard curves; collection and processing of soil and water

samples in the field; estimation of physico-chemical parameters of soil and water; collection and identification of plankton and benthos; calculation of doses for pond liming and fertilization; and design and fabrication of water filtering devices.

2. **For Student:** Individual visit to a local fish/ shrimp farms and hatcheries or to a laboratory in college/university/research organization/private sector and study the soil and water quality. Submission of a hand-written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: *Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements.*
5. Unit tests (IE).

b) Suggested Co-Curricular Activities:

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying tools /kits used for soil and water analyses and their handling, operational techniques with safety and security, IPR)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in soil and water analyses.
5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visits to fish and shellfish culture farms, hatcheries, research organizations, etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hours

SECTION-A (Total: 10 Marks)

Very Short Answer Questions (Total: 5 x2 = 10 Marks)

SECTION-B (Total: 5x5=25 Marks)
(Answer any **five** questions. Each answer carries 5 marks)
(At least 1 question should be given from each Unit)

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SECTION-C (Total: 4x10 = 40 Marks)

(Answer any **four** questions. Each answer carries 10 marks)

(At least 1 question should be given from each Unit)

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Suggested Question Paper Model for Practical Examination

Semester – V/ Aquaculture Course – 6A (Skill Enhancement Course)

Soil and Water Quality Management

Max. Time : 3 Hours Max. Marks : 50

1. Determination of a soil parameter **'A'** 8 M
2. Estimation of a water parameter by titrimetry **'B'** 8 M
3. Estimation of a water parameter by colorimetry/ spectrophotometry **'C'** 12 M
4. Identification, salient features and ecological importance of the following. 4x3=12 M
   a. Phytoplankton/ Algae
   b. Zooplankton
   c. Aquatic weed
   d. Benthic organism
5. Record + Viva-voce 6+4 = 10 M

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Semester-Wise Revised Syllabus under CBCS, 2020-21

Course code:

Four-year B.Sc.

Domain Subject: **AQUACULTURE**

IV Year B.Sc. – Semester-V

Course 7A: **ORNAMENTAL FISH CULTURE**

(Skill Enhancement Course (Elective), 05 Credits)

Max Marks: Theory: 100 + Practical: 50

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Acquire knowledge on the status of world and Indian ornamental fish farming and trade
2. Identify various commercially important freshwater and marine ornamental fishes
3. Fabricate, set up and maintain the freshwater and marine aquaria
4. Demonstrate skills for breeding and larval rearing of ornamental fishes
5. Develop the commercial production units for large scale production of ornamental fishes and aquarium plants and their trade.

II. Syllabus: *(Total Hours: 90 including Teaching, Lab, Field Training and Unit tests, etc.)*

Unit-1: Status of Ornamental fish farming and trade (10h)

1. Global status of ornamental fish trade and export potential.
2. Present status and prospects of ornamental fish farming and trade in India. Indian ornamental fish diversity and its status. Major marine ornamental fish resources of India. Method of collection of live fish.
3. Types of aquaria – Home and Public aquaria (freshwater and marine), Oceanarium.

Unit-2: Ornamental fishes (10h)

1. Origin and Benefits of ornamental fish keeping as a hobby.
2. Freshwater ornamental fishes – their taxonomy and biology - varieties of Gold fish Koi, Barbs, Danios (cyprinids); Gourami, Betta (anabantids); Tetras (characins), Live bearers (Guppy, molly, sword tail, platy); Angel fish and other Cichlids, Catfishes, Loaches.
3. Marine ornamental fishes– varieties and their habitats. Other ornamental organisms– anemones, worms, lobsters, shrimps, octopus, starfish.

Unit-3: Aquarium Management (10h)

1. Fabrication, setting up and maintenance of freshwater and marine aquarium - Lighting and aeration - Aquarium plants and their propagation methods - Aquarium accessories and decoratives. Selection of fishes and Species compatibility for aquarium keeping.
2. Water quality management for freshwater and marine aquariums. Water filtration systems – biological, mechanical and chemical. Types of filters.
3. Aquarium fish feeds – Live feeds, Dry and wet feeds. Pigmented feeds for color enhancement, larval feeds and feeding.
4. Common diseases of aquarium fish - diagnosis and treatment. Control of snail and algal growth. Medicines and chemicals used in aquaria.

Unit-4: Breeding and Rearing of ornamental fishes (10h)

1. Breeding of Live bearers and Egg layers – sex identification, conditioning of parent fish, stimulating spawning, parental care, hatching, and fry rearing.
2. Breeding of marine ornamental fishes (clown and damsel fishes) and larval rearing.
3. Application of genetics and biotechnology for quality strain production.

Unit-5: Commercial Production of Aquarium fish and Plants (10h)

1. Commercial production units of ornamental fish - requirements and design
2. Commercial production of live bearers, goldfishes, gouramies, barbs, angels and tetras.
3. Mass production of aquarium plants.
4. Fish conditioning, packing, transport and quarantine methods. Retail marketing and export of ornamental fish.

Practical Syllabus: Course 7A: **Ornamental Fish Culture**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Identify the common ornamental fishes and aquarium plants.
2. Fabricate a glass aquarium and set up with equipment and accessories
3. Maintain the fishes in aquarium with proper water quality, feeding and disease management.
4. Exhibit skills for breeding egg-layers and live-bearers and fry rearing.
5. Condition the fish for packing and transport.

IV. Practical Syllabus:

1. Identification of common freshwater and marine aquarium fishes
2. Construction of a glass aquarium
3. Setting up and maintenance of aquarium (maintained by students can be evaluated after one month)
4. Water quality management in freshwater and marine aquariums
5. Identification of Aquarium plants and live food organisms, and decoratives
6. Aerators and Types of Filters
7. Breeding of egg layers (Gold fish), live bearers (Guppy) and bubble nest builder (Gourami)
8. Ornamental fish diseases and their diagnosis and treatment. Calculation of medicine/ chemical treatment dosages.
9. Conditioning and packing of ornamental fishes.

V. References:

1. Ramachandran, A. (2002). Manual on breeding, farming and management of ornamental fishes. School of Industrial Fisheries, Cochin, India.
2. Biswas, SP., Das, JN., Sarkar, UK and Lakra, WS (2007). Ornamental Fishes of North East India: An Atlas. ICAR, National Bureau of Fish Genetic Resources, Lucknow, India.
3. Dick Mills (1998). Aquarium Fishes, Dorling Kindersly Ltd., London.
4. Spotte, S. (1993). Marine Aquarium Keeping. John Wiley and Sons, USA.
5. Kurup, BM., Harikrishnan, M. and Renjithkumar, CR (2012). Breeding, farming and trade

of ornamental fishes in India-Prospects and challenges. Souvenir- Ornamentals Kerala 2012.
6. Jameson, JD. and Santhanan, R. (1996). Manual of Ornamental Fishes and Farming Technologies, Fisheries College and Research Institute, Tuticorin.
7. Murthy, VS. (2002). Marine ornamental fish resources of Lakshadweep. CMFRI special publication, 72, 1-134.
8. Olivier, K. (2003). World trade in ornamental species (pp.49-63). Iowa State Press.
9. Van Ramshorrt, JD. (1978). The complete aquarium encyclopedia, Elsevier publishers.
10. Zaidi, S.G.S. Training manual on Ornamental fish culture. CIFE-ICAR, Mumbai.
11. Cato, JC. And Brown, CL. (Eds.) (2008). Marine ornamental species: collection, culture and conservation. John Wiley & Sons.
12. Bunting, BW., Holthus, P. and Spalding, S. (2003). The marine aquarium industry and reef conservation. Marine Ornamental Species: Collection, Culture and Conservation, 109-124.
13. Santhanam, R., Sukumaran, N. and Natarajan, P. (1987). Manual of Freshwater Aquaculture. Oxford & IBH Publishing.
14. Sirajudheen, TK., Salim, SS., Bijukumar, A. and Antony, B. (2014). Problems and prospects of marine ornamental fish trade in Kerala, India. J. Fish. Eco. Dev., 1151:14-30.
15. *Web resources suggested by the teacher concerned and the college librarian including reading material.*

VI. Co-Curricular Activities:

a) Mandatory: *(Training of students by teacher on field related skills: 15 hours)*

1. **For Teacher**: Training of students by teacher in laboratory and field for a total of 15 hours on the biology of freshwater and marine ornamental fishes, setting up and maintenance of aquarium, breeding and commercial production of aquarium fishes and plants, and packing and transport of ornamental fishes.
2. **For Student**: Individual visit to public aquaria, oceanarium, and commercial ornamental fish production farms, or to a university/research organization with ornamental fish production units and study the breeding, culture, marketing and export of ornamental fish. Submission of a hand written Field work Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05
4. Suggested Format for Field Report: *Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements*.
5. Unit tests (IE).

b) Suggested Co-Curricular Activities:

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying biofilters, aerators, accessories and their maintenance).
3. Seminars, Group discussions, Quiz, Debates, etc. (on related topics).
4. Preparation of videos on aquarium keeping, breeding and larval rearing of ornamental fishes
5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visits to ornamental fish farms, public aquaria, oceanarium and aquarium fish production facilities in research organizations, etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hours

SECTION-A (Total: 10 Marks)

Very Short Answer Questions (Total: 5 x2 = 10 Marks)

SECTION-B (Total: 5x5=25 Marks)
(Answer any **five** questions. Each answer carries 5 marks)
(At least 1 question should be given from each Unit)

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SECTION-C (Total: 4x10 = 40 Marks)
(Answer any **four** questions. Each answer carries 10 marks)
(At least 1 question should be given from each Unit)

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Suggested Question Paper Model for Practical Examination
Semester – V/ Aquaculture Course – 7A (Skill Enhancement Course)
Ornamental Fish Culture

Max. Time : 3 Hours Max. Marks : 50

1. Identification of two freshwater aquarium fishes **'A'** 8 M
2. Identification of two marine aquarium fishes **'B'** 8 M
3. Demonstration of breeding technique of egg layers/ live bearers **'C'** 12 M
4. Write about the following. 4 x 3 = 12 M
   a. Aerators
   b. Biofilters
   c. Aquatic plant
   d. Live feed / Fish disease and its treatment
5. Record + Viva-voce 6+4 = 10 M

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Semester-Wise Revised Syllabus under CBCS, 2020-21

Course code:

Four-year B.Sc.

Domain Subject: **AQUACULTURE**

IV Year B.Sc. – Semester-V

Course 6B: **TECHNIQUES FOR AQUA LAB**

(Skill Enhancement Course (Elective), 05 Credits)

Max Marks: Theory: 100 + Practical: 50

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the basic concepts in laboratory techniques.
2. Analyze and assess the soil and water quality in culture ponds.
3. Familiarize with the biochemical techniques used in aqua labs
4. Know the microbial techniques for disease diagnosis
5. Diagnose the diseases of fish and shrimp and suggest the remedial measures.

II. Syllabus: *(Total Hours: 90 including Teaching, Lab, Field Training and Unit tests etc.)*

Unit-1: Basic concepts in Laboratory Techniques (10h)

1. Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware.
2. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different chemical doses in field applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values.
3. Use and handling of microscope, laminar flow, autoclave, vacuum pumps, balances, thermometer, centrifuge, magnetic stirrer, desiccators, muffle furnace, ovens, incubators, waterbath; Electric wiring and earthing.

Unit-2: Soil and Water Testing (10h)

1. Analytical methods: Principle and applications of titrimetry, gravimetry, potentiometry, conductometry, refractometry, colorimetry, turbidimetry, spectroscopy (UV- Vis, Flame, AAS); Computerized instrument systems.
2. Water analysis: Collection and preservation of water samples; Measurement of temperature, transparency. Estimation of dissolved oxygen, pH, free carbon dioxide, total alkalinity, total hardness, turbidity, conductivity, salinity, chlorinity, total solids, ammonia, nitrites, nitrates, phosphates, BOD. Analysis of pollutants and toxic gases. Plankton analysis: Collection, identification, enumeration and biomass estimation of phytoplankton and zooplankton, and benthos.
3. Soil testing: Soil Texture and Structure, pH, Available Nitrogen, Available Phosphorus, Organic Carbon.

Unit-3: Biochemical Techniques (10h)

1. Basic principles and applications of chromatographic techniques: Paper, TLC, GC, LC, HPLC, affinity chromatography and ion exchange chromatography. Types and applications of centrifuges.
2. Feed analysis: Preliminary examination-history, colour, odour, texture, water solubility. Proximate analysis– Estimation of crude protein, crude lipid, moisture, ash, fibre, NFE (nitrogen free extracts).
3. Analysis of glucose, proteins, lipids, RNA and DNA in fish tissues by spectrophotometry.

Unit-4: Microbiological Techniques (10h)

1. Techniques in Sterilization, Preparation of media, Inoculation, Enumeration of bacteria; staining techniques; Safety in microbiology laboratory; bio-safety levels.
2. Isolation, culture and identification of bacteria and virus. Basics of mycological and virological techniques.
3. Working principles and applications of bright field microscopy, PCR and ELISA. Applications of diagnostic techniques - Gel Electrophoresis, Agglutination test, Blotting techniques, LC-MS and GC-MS.

Unit-5: Disease diagnosis (10h)

1. Collection and handling of fish/shellfish for disease diagnosis, Clinical and post-mortem examination (autopsy) of diseased fish and shellfish. Collection and identification of parasites from fish and shellfish.
2. Morphological and biochemical tests for bacteria and fungi; Molecular and Immunological techniques for disease diagnosis. Antibiotic sensitivity assays.
3. Assessment of seed quality - stress test. Aqua Medicines in the market and Banned Antibiotics. Disease treatment: Dose calculation, Treatment schedule and Administration of chemicals and drugs for treating common diseases. Quarantine and health certification in aquaculture.

Practical Syllabus: Course 6B: **Techniques for Aqua Lab**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Acquaint with the equipment and instruments used in Aqua labs.
2. Familiarize with the techniques of soil and water testing.
3. Analyze the proximate composition of feeds and fish/shrimp tissues.
4. Develop microbial cultures to enable morphological and biochemical tests for the identification of microbes.
5. Diagnose the microbial diseases by molecular and immunological techniques.

IV. Practical Syllabus:

1. Preparation of chemical solutions of various concentrations (Molarity, molality, normality, percent, ppm)
2. Preparation of Buffers and Reagents.
3. Estimation of soil and water quality parameters. Documentation and Analysis reports.

4. Interpretation of water quality data for evaluation of aquatic health – Case study.
5. Collection, preservation and quantitative estimation of phytoplankton and zooplankton; Identification of various phytoplankton and zooplankton
6. Feed analysis: Preliminary examination and proximate composition of feed.
7. Estimation of moisture, protein, total lipids and glucose content in fish tissue.
8. Identification of Amino acids by paper chromatography.
9. Knowledge on Proximate composition of Branded Feeds available in the market.
10. Methods to identify quality seed.
11. Collection, preservation and Identification of disease causing agents/parasites.
12. Preparation of media for culture.
13. Familiarization with techniques of bacterial culture, Identification; fungal isolation and characterization.
14. Demonstration of PCR, ELISA, Agarose gel electrophoresis, Agglutination test and blotting techniques.
15. Preparation of the list of chemicals and drugs used to control the diseases.
16. Determination of dose and mode of administration of chemicals and drugs for treating common diseases.
17. Preparation of case studies of diseased fish and shrimp.

V. References

1. APHA (2012). Standard Methods for the Examination of Water and Waste water: 22nd edition. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, Washington, D.C.
2. Chatopadhyay, GN. (1998). Chemical analysis of Fish Pond Soil and Water. Daya Publishing House, Delhi.
3. Boyd, CE and Tucker, CS. (1992). Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
4. Boyd, CE. (1979). Water quality in warm water fish ponds. Auburn University.
5. Welch PS. (2003). Limnological Methods. Narendra Publ. House.
6. Wetzel, RG. and Likens, GE.(1991). Limnological Analyses. Springer-Verlag, New York
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8. Sparks DL, et al. (Eds.). (1996). Methods of Soil Analysis: Part 3. Chemical Methods. SSSA-ASA, Madison.
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11. Parsons TR, Maita Y and Lalli CM. (1984). A manual of Chemical and Biological Methods for Seawater Analysis. Pergamon Press.
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13. Galan,WE.(1985). Instrumental methods of Chemical analysis. McGraw-HillBook Company
14. Hobart, HWL.et al. (1986). Instrumental Methods of Analysis. 6th Edn. CBS Publishers and Distributors, Delhi.
15. Douglas A. et al. (2017). Principles of Instrument Analysis. 7th Edn. Cengage learning Publ.

16. GilianMc Mohan (2007). Analytical Instrumentation. A Guide to laboratory, portable and miniaturized Instruments. 1st Edn. Wiley Interscience.
17. Rasan Katoch (2011). Analytical techniques in Biochemistry and Molecular Biology. 1st Edn. Springer-Verlag New York.
18. Aravind Kumar (2008). Aquatic Environment and Toxicology. Daya Publishing House, New Delhi.
19. Nelson DL and Cox MM. (2005). Lehninger Principles of Biochemistry. WH Freeman.
20. Murray RK, Granner DK, Mayes PA & Rodwell VW. (2000). Harper's Biochemistry. Appleton & Lange.
21. Wilson K & Walker J. (2002). Practical Biochemistry: Principles and Techniques. Cambridge University Press, Oxford.
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33. Sindermann CJ. (1990). Principal Diseases of Marine fish and Shellfish (Vol. 1). Gulf Professional Publishing.
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39. Biswas KP. (2000). Prevention and control of fish and prawn diseases. Narendra Publishing House, Delhi.
40. *Web resources suggested by the teacher concerned and the college librarian including reading material.*

VI. Co-Curricular Activities:

a) Mandatory: *(Training of students by teacher on field related skills: 15 hours)*

1. **For Teacher:** Training of students by teacher in laboratory and field for a total of 15 hours on collection and preservation of water, soil and biological samples in the field; maintenance of lab and equipment; preparation of chemical solutions of various concentrations; testing of soil and water including plankton, benthos and microbial analysis; feed analysis; disease diagnosis and treatment; analysis report preparation and documentation.
2. **For Student:** Individual visit to a fish/shrimp farm or hatchery for sample collections or to a laboratory in university/research organization/private sector and study the laboratory techniques for testing soil, water, feed and diseases. Submission of a hand written Field work report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: *Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements*.
5. Unit tests (IE).

b) Suggested Co-Curricular Activities:

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying tools/kits used for sample collection and testing, and their handling and operation).
3. Seminars, Group discussions, Quiz, Debates, etc. (on related topics).
4. Preparation of videos on tools and techniques in Aqua lab operation.
5. Collection of material/figures/photos related to Aqua lab techniques, writing and organizing them in a systematic way in a file.
6. Visits to research organizations to undergo training on biochemical and microbiological techniques.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hours

SECTION – A (Total: 10 Marks)

Very Short Answer Questions (Total: 5x2 = 10 Marks)

SECTION – B (Total: 5x5=25 Marks)
(Answer any **five** questions. Each answer carries 5 marks)
(At least 1 question should be given from each Unit)

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SECTION – C (Total: 4x10 = 40 Marks)

(Answer any **four** questions. Each answer carries 10 marks)

(At least 1 question should be given from each Unit)

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Suggested Question Paper Model for Practical Examination

Semester – V/ Aquaculture Course – 6B (Skill Enhancement Course)

Techniques for Aqua Lab

Max. Time : 3 Hours Max. Marks : 50

1. Determination of a water / soil parameter **'A'** 8 M
2. Feed / Fish tissue biochemical analysis (protein/ lipid/glucose, etc.) **'B'** 8 M
3. Demonstration of a microbiological technique **'C'** 12 M
4. Demonstration of a disease diagnostic technique **'D'** 12 M
5. Record + Viva-voce 6+4 = 10 M

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Semester-Wise Revised Syllabus under CBCS, 2020-21

Course code:

Four-year B.Sc.

Domain Subject: **AQUACULTURE**

IV Year B.Sc. – Semester-V

Course 7B: **FISH PROCESSING TECHNOLOGY**

(Skill Enhancement Course (Elective), 05 Credits)

Max Marks: Theory: 100 + Practical: 50

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Acquaint with the handling of fresh fish, and principles of fish processing
2. Understand various methods of fish/shellfish preservation
3. Demonstrate skills for the processing of various fish by-products
4. Know the preparation and advantages of value added fish and shellfish products
5. Understand the quality assurance and quality control standards in fish processing plants.

II. Syllabus: *(Total Hours: 90 including Teaching, Lab, Field Training and Unit tests, etc.)*

Unit-1: Principles of Fish processing and preservation (10h)

1. Aims of fish processing. Handling, storage and transport of fresh fish, Importance of hygiene and sanitation in fish handling. Quality of water and ice in fish handling and processing.
2. Post mortem changes (rigor mortis and spoilage), Spoilage of marine and freshwater fish and shellfish. Containers for packaging and transportation of fish. Use of chemical preservatives, and Irradiation in extending shelf-life of finfish and shellfish**.**
3. Principles of fish preservation- Cleaning, lowering of temperature, raising of temperature, denudation, use of salt, use of fish preservatives, exposure to low radiation of gamma rays.

Unit-2: Methods of fish/shellfish Preservation (10h)

1. Traditional methods - Sun drying, Salting, Smoking and Pickling /Marinating.
2. Advanced methods – Chilling or icing, refrigerated or chilled sea water, freezing, Accelerated freeze drying and packing of freeze dried products, Canning.
3. Modern methods - Irradiation and modified atmospheric storage.

Unit-3: Processing and preservation of fish by-products (10h)

1. Preparation and uses of fish meal, fish body oil, fish liver oil, Fish protein concentrate, Fish hydrolysates, fish meat, fish silage, fish maws, shark leather, fish manure and guano, fish glue, fish gelatin, fish factice, isinglass, fish fins, fish roe and fish cavier. Significance of biochemical and pharmaceutical products – Insulin, fish albumin, peptones, fish sutures, ambergiris, etc.
2. Production and uses of Chitin and Chitosan (shrimp wastes); Pearl essences and Beche-de-mer.
3. Utilization of sea weeds – agar-agar, alginic acid, alginate, mannitol, carrageenan, nori.

Unit-4: Value added products (10h)

1. Status of value addition to fish and fish products in Indian seafood sector. Advantages of value addition.
2. Different types of value added products from fish and shellfish**:** Preparation and uses of Marinated and fermented products, Fish paste products and Diversified (battered and breaded) products - Fish and prawn pickles, fish sauce, surimi, f**ish sausage, fish ham, fish cake, kamaboko, fish macaroni, fish biscuits, fish burger,** fish mince, fish finger, fish cutlet, fish wafer, fish chowder, fish soup, fish stacks, fillets, fish curry, fish papad, mussel products, etc.
3. Packing and Labelling of fish and fishery products. Cold Storages and Export of Fishery Products.

Unit-5: Quality Management and Certification (10h)

1. Quality Assurance – Concepts of Hazard Analysis Critical Control Point (HACCP) in sea food safety; Good Manufacturing Practices (GMPs), Standard Operating Procedures (SOPs). Determining the quality assurance of sea food.
2. Sanitation and Quality control – Environmental hygiene and personal hygiene in processing plants. Good Hygienic practices (GHPs). Sanitary Standard Operating Procedures (SSOP). Basic concepts and quality control of fish processing.
3. National and International standards – ISO 9000: 2000 Series of Quality Assurance System, Codex Alimentarius.

Practical Syllabus: Course 7B: **Fish Processing Technology**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Execute various techniques of fish preservation.
2. Assess the quality of processed fish and fish by-products.
3. Familiarize with fish packaging materials and containers.
4. Prepare common fish/shellfish by-products and value added products.
5. Assess the sanitation and quality control standards in fish processing plants.

IV. Practical Syllabus:

1. Techniques of fish preservation: Preparation of dried fish, salted fish and smoked fish by different methods.
2. Organoleptic analysis of fish. Quality assessment of salted, dried and smoked fish
3. Types of cans, canning equipment and layout of cannery. Canning of fish/shrimp.
4. Acquaintance with various packaging materials and containers for fish products.
5. Assessment of quality of packaging materials used for packaging of fish and fish products.
6. Preparation of 10 fish/shellfish by-products
7. Preparation of 10 value added products of fish and shellfish: prawn and fish pickles, fermented fish sauce, fish paste products, diversified fish products.
8. Collection of fishery by-products
9. Quality assessment of individual by-products and value added products.
10. Assessment of sanitation in fish processing plants
11. HACCP and GMP with SSOP.

V. References:

1. Gopakumar K. (2002). Text Book of Fish Processing Technology. ICAR.
2. Govindhan, TK. (1985). Fish processing Technology. Oxford & IBH Publ. Co., New Delhi.
3. Hall, GM. (1992). Fish Processing Technology. Blackie. Springer science and business.
4. Balachandran KK. (2001). Post-harvest Technology of Fish and Fish Products. Daya Publ.
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6. Sen, D.P. (2005). Advantages in Fish Processing Technology. Allied publ. Pvt.Ltd. Mumbai
7. Wheaton, FW. and Lawson, TB. (1985). Processing Aquatic Food Products, A Wiely-Inter Science Publication. USA.
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9. Venugopal V. (2006). Seafood Processing. 1st edition Boca Raton CRC Press.
10. Shahidi, F. and Botta, JR.(1994). Seafoods chemistry, Processing Technology and Quality. Blakie Academic and Professional, U.K.
11. Surendran, PK., Nirmala,T, Narayanan, NV. and Lalitha, KV. (2003). Laboratory Manual on Microbiological Examination of Sea food, CIFT, Cochin.
12. Velayutham, P. and Indira Jasmine, G. (1996). Manual on Fishery By-Products, Tamilnadu Veterinary and Animal Sciences University, Chennai.
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14. Winton & Winton. (1999). Fish and Fish Products. Allied Scientific Publishers.
15. Balachandran, KK. (2004). Fish Canning Principles and Practices. Central Institute of Fisheries Technology, ICAR, Cochin.
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20. Huss, HH. et al. (1992). Quality Assurance in the Fish Industry. Elsevier Science Publishers, B.V., Amsterdam, Netherlands.
21. Bond, et al. (1971). Fish Inspection and Quality Control. Fishing News Books, England.
22. Jaya Shakila, R. and Sukumar, D. (2006). Text Book of Quality and Safety of Sea foods. Tamilnadu Veterinary and Animal Sciences University, Chennai.
23. *Web resources suggested by the teacher concerned and the college librarian including reading material.*

VI. Co-Curricular Activities:

a) Mandatory: *(Training of students by teacher on field related skills: 15 hours)*

1. **For Teacher:** Training of students by teacher in laboratory and field for a total of 15 hours on processing and preservation of fish/shellfish and their by-products and value added products; and the quality management and certification in fish processing.
2. **For Student:** Individual visit to a fish processing plant or related field or to a laboratory in research organization/private sector and study the sanitation measures followed while handling, storage and transport of fresh fish for further processing, various methods of processing and preservation of fish/shellfish and their products, packaging and labeling,

cold storage and export. Also study the sanitary procedures, HACCP and GMPs implemented for quality assurance and quality control of seafood in fish processing plants. Submission of a hand written Fieldwork Report not exceeding 10 pages in the given format.

3. Max marks for Field Work Report: 05.
4. Suggested Format for Field work: *Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements*.
5. Unit tests (IE).

b) Suggested Co-Curricular Activities:

1. Training of students by related industrial experts.
2. Assignments (including the preparation of novel value added products and processing of fish products)
3. Seminars, Group discussions, Quiz, Debates, etc. (on related topics).
4. Preparation of videos on fish/shellfish processing and various methods of preserving fish/fish products, preparation of value added products, packaging, labelling, etc,
5. Collection of material/figures/photos related to fish processing, preservation and value added products, writing and organizing them in a systematic way in a file.
6. Visits to fish processing plant/industry, firms, research institutes, etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hours

SECTION – A (Total: 10 Marks)

Very Short Answer Questions (Total: 5x2 = 10 Marks)

SECTION – B (Total: 5x5=25 Marks)
(Answer any **five** questions. Each answer carries 5 marks)
(At least 1 question should be given from each Unit)

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SECTION – C (Total: 4x10 = 40 Marks)
(Answer any **four** questions. Each answer carries 10 marks)
(At least 1 question should be given from each Unit)

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Suggested Question Paper Model for Practical Examination

Semester – V/ Aquaculture Course – 6B (Skill Enhancement Course)

Fish Processing Technology

Max. Time : 3 Hours Max. Marks : 50

1.	Organoleptic analysis of fish/ Fish preservation method **'A'**	8 M
2.	Fish by-products **'B'**	10 M
3.	Value added products **'C'**	10 M
4.	Demonstration of HACCP/ Sanitation and Quality control **'D'**	12 M
5.	Record + Viva-voce	6+4 = 10 M

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Semester-Wise Revised Syllabus under CBCS, 2020-21

Course code:

Four-year B.Sc.

Domain Subject: **AQUACULTURE**

IV Year B.Sc. – Semester-V

Course 6C: **AQUACULTURE ECONOMICS**

(Skill Enhancement Course (Elective), 05 Credits)

Max Marks: Theory: 100 + Practical: 50

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the concept of aquaculture economics and farm planning and budgeting.
2. Know the economic principles applied to aquaculture production.
3. Familiarize with the concepts of marketing and export of fish and fishery products
4. Assess the socio-economic conditions of fishermen and fish farmers and know the financial support they are getting from central and state government agencies.
5. Understand the global trade of fish and fish products and their contribution to Indian economy.

II. Syllabus: *(Total Hours: 90 including Teaching, Lab, Field Training and Unit tests, etc.)*

Unit-1: Principles of Economics (10h)

1. Concept of Microeconomics and Macroeconomics. Law of diminishing returns, laws of increasing, constant and decreasing utility and returns.
2. Law of equi-marginal returns. Importance of economics in aquaculture development.
3. Farm planning and budgeting: Objectives, Importance, Types, project preparation, project appraisal, Record keeping. Farm financial management: Basic accounting procedures, profit and loss account.

Unit-2: Production Economics (10h)

1. Basic economic principles applied to aquaculture production: the input-output relationships, maximum level of input, least-cost combination of inputs, maximum level of output, combination of products, economies of size.
2. Cost-Return Analysis: Production costs- fixed costs and variable costs; Gross revenue, Economic analysis.
3. Partial budget analysis, Cash flow analysis and Break-even analysis of Aquaculture practices.

Unit-3: Marketing Economics (10h)

1. Basic concepts in demand and price analysis: Demand, supply and fish prices; Elasticity of demand - Price, income and cross elasticity of demand. Methods of economic feasibility analysis: Payback period, average rate of return, discounting method - Net Present Value, Benefit-cost Ratio, Internal Rate of Return.
2. Fish markets and marketing in India, demand and supply of fish, market structure and price determination in fish markets. Cold storage and other marketing infrastructure in India. Problems of Fish marketing in India.
3. Export markets and marketing of fish and fishery products, trends and problems. Role of MPEDA in export of fish and fishery products.

Unit-4: Socio-economics (10h)

1. Socio-economic conditions of fishermen and fish farmers
2. Role of government agencies – Role of NABARD and other Central Government agencies in the upliftment of fisher folk. Role of State Government agencies in various fishery activities – Loans and credits, policies. Role of insurance in fish and shrimp farming and industry.
3. Cooperatives in Fisheries and Aquaculture: Functions, financial assistance, input supplies, marketing of fish.

Unit-5: Global trade of Fish and Fishery products (10h)

1. Introduction to GATT and WTO – IPRs, TRIPS Agreement.
2. National Income – Definitions – GDP, NDP, NNP, GNP.
3. Contribution of fisheries to Indian economy: GDP from fisheries and aquaculture sector, foreign exchange earnings and employment potential of fishery and aquaculture industry.

Practical Syllabus: Course 6C: **Aquaculture Economics**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Prepare the project proposal and project appraisal
2. Assess the cost benefit analysis of fish/shellfish production units.
3. Execute the questionnaires for market surveys and socio-economics of farmers.
4. Analyze the socio-economic conditions of fishermen and fish farmers and the role of cooperative societies.
5. Know the International trade of fish and fishery products and contribution of fisheries to Indian economy.

IV. Practical Syllabus:

1. Scope of Economics: Microeconomics and Macroeconomics - Flow charts.
2. Preparation of project proposal for loan from commercial bank or funding agencies including plan, budget and repayment schedule.
3. Farm Appraisal: A case study.
4. Study of credit schemes of banks and the government.
5. Cost benefit analysis calculations
6. Preparation of income statement
7. Costs and Returns in shrimp production unit: Case study.
8. Costs and Returns in freshwater fish production unit: Case study.
9. Costs and Returns in a freshwater fish hatchery: Case study.
10. Costs and Return in a prawn and shrimp hatchery: Cases study.
11. Developing questionnaire for conducting market surveys, and socio-economics of fishermen and fish farmers.
12. Collection and analysis of Socio-economic data of fishermen and fish farmers.
13. Fish marketing structure - Market channels – Flow chart.
14. Analysis of primary and secondary market data.
15. Case studies of Fish cooperative societies

V. References:

1. Shang YC. (1990). Aquaculture Economic Analysis – An Introduction. World Aquaculture Society, USA.
2. Singh, R.K.P. (2003). Economics of Aquaculture. Daya Publishing House, Delhi.
3. Jayaraman, R. (1996). Fisheries Economics. Tamilnadu Veterinary and Animal Science University, Tuticorin.
4. Allen, et al.(Eds). (1984). Bio-Economics of Aquaculture. Elsevier Publ.
5. Chaston I. (1987). Business Management in Fisheries and Aquaculture.Fishing News Books
6. Tripathi SD (1992). Aquaculture Economics. Asian Fisheries Society, Mangalore
7. Subba Rao N (1986). Economics of Fisheries. Daya publishing house, Delhi
8. Ian C. (1984). Marketing in Fisheries and Aquaculture. Fishing News Books.
9. Korakandy, R (1996). Economics of Fisheries Management.DayaPublishing House, Delhi
10. Dewett, K.K. and Varma, J.D. (1993). Elementary Economic Theory. S.Chand, New Delhi.
11. Sathaidhas, R. (1997). Production & Marketing Management of Marine Fisheries in India. Daya Publishing House, Delhi.
12. Kotler, Philip. (1995). Principles of Marketing. Prentice-Hall of India, New Delhi.
13. *Web resources suggested by the teacher concerned and the college librarian including reading material.*

VI. Co-Curricular Activities:

a) Mandatory: *(Training of students by teacher on field related skills: 15 hours)*

1. **For Teacher**: Training of students by teacher in laboratory and field for a total of 15 hours on the principles of economics; preparation of project proposals and credit schemes; Cost-benefit analysis of fish/shellfish production farms and hatcheries; fish markets and marketing economics; organizing and conducting socio–economic surveys to study the socio-economic status of fishermen and fish farmers; and fish cooperative societies.
2. **For Student**: Individual visit to commercial fish and shellfish farms/hatcheries to study the cost-benefit analysis, commercial banks and regional rural banks for credit schemes, fish markets to study the marketing of fish and fish products, co-operative societies, government agencies and fish export organizations. Develop advertisement skills for marketing of various products used for Aquaculture. Submission of a hand written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05
4. Suggested Format for Field Report: *Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements*.
5. Unit tests (IE).

b) Suggested Co-Curricular Activities:

1. Training of students by related industrial experts.
2. Assignments (including technical assignments on farm economics and marketing management of fish and fish products).
3. Seminars, Group discussions, Quiz, Debates, etc. (on related topics).
4. Preparation of videos on fish/shellfish markets and marketing process.
5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visits to fish/shellfish farms and hatcheries, fish markets, fish co-operative societies, etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hours

SECTION – A (Total: 10 Marks)

Very Short Answer Questions (Total: 5x2 = 10 Marks)

SECTION – B (Total: 5x5=25 Marks)
(Answer any **five** questions. Each answer carries 5 marks)
(At least 1 question should be given from each Unit)

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SECTION – C (Total: 4x10 = 40 Marks)
(Answer any **four** questions. Each answer carries 10 marks)
(At least 1 question should be given from each Unit)

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Suggested Question Paper Model for Practical Examination
Semester – V/ Aquaculture Course – 6C (Skill Enhancement Course)
Aquaculture Economics

Max. Time : 3 Hours Max. Marks : 50

1. Project proposal for loan from banks or funding agencies **'A'** 12 M
2. Cost-benefit analysis of fish/shellfish production farms **'B'** 12 M
3. Marketing structure – Flow chart **'C'** 8 M
4. Demonstration of role of fish cooperative societies/government agencies **'D'** 8 M
5. Record + Viva-voce 6 + 4 = 10 M

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Semester-Wise Revised Syllabus under CBCS, 2020-21

Course code:

Four-year B.Sc.

Domain Subject: **AQUACULTURE**

IV Year B.Sc. – Semester-V

Course 7C: **FISH MICROBIOLOGY AND QUALITY ASSURANCE**

(Skill Enhancement Course (Elective), 05 Credits)

Max Marks: Theory: 100 + Practical: 50

I. Learning Outcomes:

Students after successful completion of the course will be able to:

1. Understand the history and importance of microorganisms in fish foods.
2. Know the microorganisms in fresh and processed fish foods, the factors affecting the microbial growth and their role in food spoilage.
3. Acquire knowledge on microbes involved in food borne infections and intoxications.
4. Ascertain the various ways of fish spoilage and its control.
5. Maintain the sanitary and quality standards in fish processing industries.

II. Syllabus: *(Total Hours: 90 including Teaching, Lab, Field Training and Unit tests, etc.)*

Unit-1: History and Significance of microbes in foods (10h)

1. History of microorganisms in foods. Role and significance of microorganisms in foods.
2. Microbial principles of fish preservation and processing- application of low temperature, high temperature, drying, irradiation and chemicals.
3. Enumeration of microorganisms in food by conventional and rapid techniques.

Unit-2: Microorganisms in fish (10h)

1. Microorganisms in fresh and processed fish – raw fish, chilled fish, frozen fish, cured fish, canned fish, fermented, irradiated, value added and other miscellaneous fish products. Isolation and identification of common bacteria.
2. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in fish.
3. Psychrophiles, halophiles and thermophiles, their role in spoilage and food poisoning.

Unit-3: Microbes of public health concern (10h)

1. Study of bacteria involved in foodborne infections and intoxications– *Vibrio parahaemolyticus, V. cholerae, Listeria monocytogenes, Clostridium, Salmonella, Shigella, Staphylococcus, E. coli.*
2. Biological hazards associated with fish and fishery products: Marine toxins; mycotoxins, parasites and viruses.
3. Occurrence, growth, survival, pathogenicity, prevention and risk assessment of common bacteria present in fish.

Unit-4: Fish spoilage (10h)

1. Types of spoilage of fish and fish products. Indicators/Indices of fish spoilage.
2. Microbial spoilage of fish/shellfishand its prevention/control.
3. Assessment of quality of fish and fishery products.

Unit-5: Sanitary and Quality management (10h)

1. Bacteria of sanitary significance. Quality Indicators of fish products. Disinfectants, detergents and cleaning schedule. Process water quality in fish processing industries.
2. Concepts of Quality Management; TQM, SSOP, GHP,GMP.
3. Quality standards for fish and fishery products – BIS, FSSAI, Codex Alimentarius, ISO 9000 series and HACCP. Microbiological standards and criteria.

Practical Syllabus: Course 7C: **Fish Microbiology and Quality assurance**

III. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Collect and process the fish/shellfish samples for microbial studies.
2. Establish the laboratory for the isolation and culture of microorganisms
3. Identify and Enumerate the microbes in water, ice, fish and fishery products
4. Characterize the bacteria by biochemical tests and detect them by molecular, conventional and rapid methods.
5. Assess the indices of freshness and quality of fresh and processed fish/shellfish.

IV. Practical Syllabus:

1. Sampling and processing of fish/shellfish samples for microbiological investigation.
2. Sterilization techniques, Media preparation, Isolation and maintenance of bacteria, and Gram staining of bacteria.
3. Conventional and rapid methods for detection of microorganisms.
4. Enumeration of microorganisms associated with fish/shellfish and fishery products – Total plate count (TPC).
5. Enumeration of microorganisms in water and ice.
6. Isolation and identification of foodborne pathogens in fish/shellfish and fishery products.
7. Enumeration of specific spoilage microbes from fish and fishery products.
8. Biochemical tests for characterization of bacteria.
9. Molecular methods for the detection of pathogenic microorganisms.
10. Determination of MIC and MBC of chemical preservatives.
11. Assessment of freshness of fish and shrimp by using organoleptic characters.
12. Assessment of sanitation in fish processing plants.
13. Determination of available chlorine.

V. References:

1. Chichester, CO. and Graham, HD. (Eds.). (2013). Microbial safety of fishery products. Academic Press.
2. Gopakumar, K. (2002). Text Book of Fish Processing Technology. ICAR Publ. New Delhi.
3. Connell, JJ. (1995). Control of Fish Quality. Fishing News Books.

4. Jeyasekharan, G., Jaya Shakila, R. and Sukumar, D. (2006). Quality and Safety of Sea foods – Text Book. Tamilnadu Veterinary and Animal Sciences University, Chennai.
5. Huss HH, Jakobsen M and Liston J. (1992). Quality Assurance in the Fish Industry. Elsevier Science Publishers, B.V., Amsterdam, Netherlands.
6. Surendran, PK, Nirmala T, Narayanan NV. and Lalitha, KV. (2003). Laboratory Manual on Microbiological Examination of Sea food, CIFT, Cochin.
7. Quality Assurance in seafood processing. (2005). CIFT Publ.,Cochin.
8. Huss, HH. (1994). Assurance of Seafood Quality. FAO Fisheries Technical Paper 334, FAO, Rome, Italy.
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10. Bonell, AO. (1994). Quality Assurance in Seafood Processing: A practical Guide. Chapman and Hall, New York.
11. Wheaton, FW. and Lawson, TB.(1985). Processing Aquatic Food Products, A Wiely-Inter Science Publication. U.S.A.
12. Guthrie, RK. (1988). Food Sanitation. Van Nostrand Reinhold, New York.
13. Amerine, MA, Pangborn, RM. and Roessler, EB. (2013). Principles of sensory evaluation of food. Elsevier.
14. Govindhan, TK. (1985). Fish processing Technology. Oxford & IBH Publ. Co., New Delhi.
15. Balachandran, KK. (2001). Post-harvest technology of fish and fish products. Daya Publ.
16. Anthony, TT. (1988). Handbook of Natural toxins, Marine toxins and Venom. Vol.III. Marcel Dekker.
17. *Web resources suggested by the teacher concerned and the college librarian including reading material.*

VI. Co-Curricular Activities:

a) Mandatory: *(Training of students by teacher on field related skills: 15 hours)*

1. **For Teacher**: Training of students by teacher in laboratory and field for a total of 15 hours on the importance of microbes in fish and fish products, microbial principles of fish preservation and processing, microbes of public health concern, microbial fish spoilage, sanitary and quality management in fish processing industries.
2. **For Student**: Individual visit to a fish processing plant or related field or to a laboratory in research organization/private sector and study the isolation, culture and enumeration of microbes in water, ice, fish and fish products, detecting microbes by biochemical tests and molecular methods, assessment of freshness and quality of fresh and processed fish/ shellfish, quality assurance in fish processing plants. Submission of a hand written Fieldwork Report not exceeding 10 pages in the given format.
3. Max marks for Field Work Report: 05.
4. Suggested Format for Field Report: *Title page, student details, content page, introduction, work done, findings, conclusions and acknowledgements*.
5. Unit tests (IE).

b) Suggested Co-Curricular Activities:

1. Training of students by related industrial experts.
2. Assignments(including technical assignments on Quality Assurance in processing plants)
3. Seminars, Group discussions, Quiz, Debates, etc. (on related topics).
4. Preparation of videos on fish/shellfish processing and various methods of preserving fish/shellfish and fish products.

5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visit to fish processing plant for the study of sanitary and quality standards followed, firms, research organizations, etc.
7. Invited lectures and presentations on related topics by field/industrial experts.

VII. Suggested Question Paper Pattern:

Max. Marks: 75 Time: 3 hours

SECTION – A (Total: 10 Marks)

Very Short Answer Questions (Total: 5x2 = 10 Marks)

SECTION – B (Total: 5x5=25 Marks)
(Answer any **five** questions. Each answer carries 5 marks)
(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

SECTION – C (Total: 4x10 = 40 Marks)
(Answer any **four** questions. Each answer carries 10 marks)
(At least 1 question should be given from each Unit)

1.	
2.	
3.	
4.	
5.	
6.	

Suggested Question Paper Model for Practical Examination
Semester – V/ Aquaculture Course – 7C (Skill Enhancement Course)
Fish Microbiology and Quality assurance

Max. Time : 3 Hours Max. Marks : 50

1. Media Preparation / Organoleptic evaluation of fish/fish products **'A'** 8 M
2. Sterilization techniques/ Staining techniques **'B'** 10 M
3. Isolation/ culture / characterization of bacteria from fishes and water **'C'** 10 M
4. Demonstration of HACCP / Sanitation and Quality control **'D'** 12 M
5. Record + Viva-voce 6 + 4 = 10 M

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