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)*

<table>
<thead>
<tr>
<th>Univ. Code</th>
<th>Courses 6 &amp; 7</th>
<th>Name of Course</th>
<th>Th. Hrs/ Wk</th>
<th>IE Marks</th>
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<td>6A</td>
<td>Soil and Water Quality Management</td>
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<td>7A</td>
<td>Ornamental Fish Culture</td>
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<td>6B</td>
<td>Techniques for Aqua Lab</td>
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<td>7B</td>
<td>Fish Processing Technology</td>
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<td>Fish Microbiology and Quality Assurance</td>
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**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.
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)
2. Properties of water logged soils, methane and hydrogen sulphide formation. Problem soils: Saline soils, Alkali soils, Acid sulphate soils (ASS), and their reclamation.

Unit-2: Water quality (10h)
1. Water quality parameters: Temperature, transparency, salinity, dissolved oxygen, carbon dioxide, 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)
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.
3. Water quality management in freshwater carp culture; brackishwater shrimp culture; and hatcheries.

Unit-5: Pond treatments (10h)
2. Reduction of pH; Control of turbidity, salinity, hardness and chlorides; Chlorine removal; Removal of toxic gases.

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.
   Water Analysis:
8. Estimation of Dissolved oxygen, Free carbondioxide, Total alkalinity and Total hardness in water.
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:
5. MPEDA: Handbooks on culture of carp, shrimp, etc.
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.


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)

1. Determination of a soil parameter ‘A’  
2. Estimation of a water parameter by titrimetry ‘B’  
3. Estimation of a water parameter by colorimetry/ spectrophotometry ‘C’  
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  

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
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.
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.

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.
3. Aquarium fish feeds – Live feeds, Dry and wet feeds. Pigmented feeds for color enhancement, larval feeds and feeding.
Unit-4: Breeding and Rearing of ornamental fishes (10h)
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.
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)

V. References:
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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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.
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.
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.
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)

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.
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.
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.
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
35. Felix S., et al. (2001) Fish Disease Diagnosis and Health Management. Fisheries College and Research Institute, T.N. Veterinary and Animal Sciences University, Thoothukudi.
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.


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)
**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’  
2. Feed / Fish tissue biochemical analysis (protein/ lipid/glucose, etc.) ‘B’  
3. Demonstration of a microbiological technique ‘C’  
4. Demonstration of a disease diagnostic technique ‘D’  
5. Record + Viva-voce  

\[ 6+4 = 10 \text{ M} \]
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.

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.
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, **fish 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.

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

**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
10. Assessment of sanitation in fish processing plants
11. HACCP and GMP with SSOP.
V. References:
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.

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)

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

**Fish Processing Technology**

<table>
<thead>
<tr>
<th>Max. Time: 3 Hours</th>
<th>Max. Marks: 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Organoleptic analysis of fish/ Fish preservation method ‘A’</td>
<td>8 M</td>
</tr>
<tr>
<td>2. Fish by-products ‘B’</td>
<td>10 M</td>
</tr>
<tr>
<td>3. Value added products ‘C’</td>
<td>10 M</td>
</tr>
<tr>
<td>4. Demonstration of HACCP/ Sanitation and Quality control ‘D’</td>
<td>12 M</td>
</tr>
<tr>
<td>5. Record + Viva-voce</td>
<td>6+4 = 10 M</td>
</tr>
</tbody>
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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.
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:

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.
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.
15. Case studies of Fish cooperative societies
V. References:
7. Subba Rao N (1986). Economics of Fisheries. Daya publishing house, 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 handwritten 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)

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 – 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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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)
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
1. Types of spoilage of fish and fish products. Indicators/Indices of fish spoilage.
3. Assessment of quality of fish and fishery products.

Unit-5: Sanitary and Quality management
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.
7. Enumeration of specific spoilage microbes from fish and fishery products.
8. Biochemical tests for characterization of bacteria.
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.

V. References:
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.

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)

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)

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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