

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

Domain Subject: FISHERIES
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	Fish Processing Technology	3	25	75	3	3	50	2
	7A	Fish Seed Production Technology	3	25	75	3	3	50	2

OR

	6B	Aquatic Pollution and Coastal Zone Management	3	25	75	3	3	50	2
	7B	Ornamental Fisheries	3	25	75	3	3	50	2

OR

	6C	Fisheries Extension Education	3	25	75	3	3	50	2
	7C	Microbiology of Fish and Fishery Products	3	25	75	3	3	50	2

Note-1: For Semester-V, for the domain subject Fisheries, 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.

Four-year B.Sc.

Domain Subject: **FISHERIES**

IV Year B.Sc. – Semester-V

Course 6A: **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. Know the handling of fresh fish and principles of fish preservation and processing
2. Perform various preservation techniques of fish and shellfish
3. Demonstrate skills for the preparation of various fish by-products
4. Know the preparation and advantages of value added products of fish and shellfish
5. Understand the quality control standards followed in fish processing industry.

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

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

1. Objectives of fish processing. Handling and Sanitation: Precautions taken in handling fish in the fishing vessel, landing center and processing plant.
2. Post mortem changes (rigor mortis and spoilage), Spoilage of marine and freshwater fish/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: Preservation techniques of fish/ shellfish processing (10h)

1. Principles of preservative methods – Curing (Drying, Salting, Smoking), Chilling, Freezing, Marinating and Canning.
2. Principles of freeze drying - Accelerated freeze drying and packing of freeze dried products.
3. Modern methods of preservation by 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 shellfishes: 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.
3. Packing and Labeling of fish and fishery products. Cold Storages and Export of Fishery Products.

Unit-5: Quality Assurance and Quality Control

(10h)

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

Practical Syllabus: Course 6A: 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/shell fish 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.
5. Clucas IJ.(1981). Fish Handling, Preservation and Processing in the Tropics. Parts I,II. FAO
6. Sen, DP. (2005). Advantages in Fish Processing Technology. Allied Publ. Pvt.Ltd. Mumbai.
7. Wheaton, FW. and Lawson, TB. (1985). Processing Aquatic Food Products, A Wiley-Inter Science Publication. USA.
8. Ninawe, AS. and RatnaKumar, K. (2008). Fish Processing Technology and Product Development. Narendra Publishing House, Delhi
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.
13. Ruitter. (1995). Fish and Fishery Products. CAB International Publication
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.
16. Gopakumar, K. (1993). Fish Packaging Technology–Materials & Methods. Concept Publishing Co., New Delhi.
17. Jeya Shakila, R., Sukumar, D. and Velayutham, P. (2007). Packaging of Fish and Fishery Products. TANUVASU, Tamil Nadu.
18. Quality Assurance in seafood Processing. (2005). Published by CIFT, Cochin.
19. Bonell, AO. (1994). Quality Assurance in Seafood Processing: A practical Guide. Chapman and Hall, New York.
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, labeling, 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/ Fisheries Course – 6A (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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Four-year B.Sc.

Domain Subject: **FISHERIES**

IV Year B.Sc.– Semester-V

Course 7A: **FISH SEED PRODUCTION 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. Know the natural fish and shellfish seed resources and their collection.
2. Understand the carp breeding techniques and hatchery management for seed production.
3. Acquire knowledge on the breeding techniques and seed production of other fishes.
4. Familiarize with the hatchery management of commercially important shrimps.
5. Acquaint with seed production technology of other cultivable crustaceans and molluscs.

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

Unit-1: Natural Seed resources (10h)

1. Natural breeding and Seed resources of carp in major rivers of India. Selection of riverine spawn collection sites, gears used and methods of collection. Seed resources of other freshwater fishes of India.
2. Marine finfish and shellfish - Natural habitats for seed collection and collection methods.
3. Natural shrimp seed resources, site selection and collection methods. Seed resources and collection of freshwater prawn.

Unit-2: Carp Breeding and Hatchery Management (10h)

1. Bundh breeding: Wet and dry bundhs; bundh breeding techniques; Collection and hatching of eggs; Factors influencing bundh breeding; Advantages and disadvantages of bundh breeding.
2. Induced breeding of Indian major carp by hypophysation: Fish pituitary gland – structure, collection and preservation, preparation of pituitary extract for injection, dosage calculation and methods of injection. Broodstock maintenance and selection of breeders for injection. Synthetic hormones used for induced breeding of carps.
3. Types of hatcheries and spawn production – traditional, chinese, jar and modern controlled hatcheries.

Unit-3: Breeding and Seed production of other Fishes (10h)

1. Breeding techniques and Seed production of exotic carps – Common carp and Chinese carps. Stripping and fertilization.
2. Breeding techniques and Seed production of *Channa*, *Pangasius*, *Clarias batrachus*, *Tilapia*.
3. Marine fish seed production: Seabass, milkfish, mullets, cobia and pompanos.

Unit-4: Shrimp Hatchery Management (10h)

1. General design of shrimp hatcheries. Various components, equipment and infrastructure facilities required in hatchery.
2. Operation and management of hatchery sections: Maturation section– Selection and maintenance of broodstock, induced maturation by eyestalk ablation, selection of potential spawners, spawning and hatching, quantitative and qualitative evaluation of nauplii; Larval section – shrimp life cycle, biology of shrimp larvae, larval rearing operations; Algal section and *Artemia* section; and Post larval section.
3. Health management in hatcheries. Sea water filtration and treatment processes.

Unit-5: Seed Production of other shellfish (10h)

1. Seed production and nursery rearing of *Macrobrachium rosenbergii* / *M. malcolmsonii*.
2. Seed production of crabs and lobsters.
3. Seed production of pearl oysters, edible oysters and freshwater mussel.

Practical Syllabus: Course 7A: Fish Seed Production Technology

III. Skills Outcomes:

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

1. Know the natural seed resources of different fishes and shellfishes.
2. Produce carp seed by hypophysation technique.
3. Operate different fish hatcheries for seed production.
4. Identify broodstock, eggs and larval stages of fishes and shellfishes.
5. Acquaint with the hatchery technology for seed production of shrimps and other crustaceans and molluscs.

IV. Practical Syllabus:

1. Collection of information on natural seed resources of different freshwater and marine finfish and shellfishes.
2. Selection/Identification of breeders of different fishes.
3. Dissection and collection of fish pituitary gland, preservation, extract preparation, doses determination, selection of breeders and injection to the brood fishes.
4. Use of synthetic compounds for induced breeding of fishes.
5. Study of design and operation of hapa, chinese and jar hatcheries of fishes.
6. Identification of eggs, spawn, fry and fingerlings of different fishes.
7. Study of seed production technology of cultivable fishes and shellfishes.
8. Identification of broodstock and maturity stages of important crustaceans and molluscs
9. Demonstration of eyestalk ablation in *Penaeus monodon*.
10. Identification of larval stages of common cultivable crustaceans and molluscs.
11. Water quality monitoring in fish hatcheries and nurseries.
12. Construction and working of biofilter.
13. *Artemia* nauplii production for feeding shrimp larvae.
14. Identification of different live feeds used in the marine shellfish hatchery.
15. Preparation of larval feeds and feeding.
16. Preparation of *Spirulina* based feed for broodstock and larvae.
17. Different chemicals and drugs used in shrimp/prawn hatchery.
18. Different marine shellfish hatchery models and layout preparations.

V. References:

1. Jhingran, V.G. Pullin, R.S.V. (1997). A hatchery manual for the Common, Chinese and Indian Major Carps. Asian Development Bank, International Center for Living Aquatic Resources Management, Philippines.
2. Chonder, S.L. (1994). Induced Carp Breeding. C.B.S. Publishing New Delhi.
3. Joshua, K. et al. (1993). Shrimp Hatchery Operation and Management. Marine Products Export Development Authority (MPEDA), Kochi, India.
4. Keshavanath and Radhakrishnan. (1990). Carp seed production technology, Asian Fishery Society, Indian branch, Mangalore.
5. Ramanathan, N. and Francis, T. (1996). Manual on breeding and larval rearing of cultivable fishes. Fisheries College and Research Institute, Tuticorin.
6. Aquacop.(1979). Mass production of *Macrobrachium rosenbergii* juveniles. CNEXOCOP. Tahiti French Polynesia.
7. Granvil, D. and Treece, Joe, M. Fox. (1993). Design, Operation and Training manual for an intensive shrimp hatchery- Institutional grant NA 16 RGO457-01to Texas A&M university, Sea grant college.
8. Silas, E.G. et al. (Eds.) (1985). Hatchery production of penaeid prawn seed, *Penaeus indicus* CMFRI Special publication 23. CMFRI, Kochi.
9. Thakur, N.K. et al. (Eds.) (1998). Culture of live food organisms for aqua hatcheries. Training manual. CIFE (ICAR), Mumbai.
10. *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 natural seed resources of fish and shellfish, breeding technology and hatchery management of cultivable freshwater and marine fish and shellfish for quality seed production.
2. **For Student:** Individual visit to the field for the collection of information on natural seed resources of different freshwater and marine finfish and shellfishes / visit to Hatcheries (Freshwater fish/ Brackishwater fish/ Aquarium fish/ Shrimp/ Prawn/ Bivalve) in a university/research organization/private sector to learn the seed production technology. 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 modern fish hatchery technology, aeration system, seawater filtration and treatment processes, seed quality assessment, chemicals and drugs used for health management in hatcheries).
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in pollution and CRZ studies.

5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visits to hatcheries for Hatchery training (Freshwater fish/ Brackishwater fish/ Aquarium fish/ Shrimp/ Prawn/ Bivalve) and for the observation of different disease conditions in brood stock and larvae; live feed production unit in hatchery facility / research organizations - CMFRI, 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/ Fisheries Course – 7A (Skill Enhancement Course)
Fish Seed Production Technology

Max. Time : 3 Hours

Max. Marks : 50

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|---|--------------|
| 1. Demonstration of eyestalk ablation in <i>Penaeus monodon</i> 'A' | 8 M |
| 2. Demonstration of fish hatcheries/ shrimp hatchery 'B' | 8 M |
| 3. Demonstration of hypophysation technique in Indian major carps 'C' | 12 M |
| 4. Identification, salient features and importance of the following. | 4 x 3 = 12 M |
| a) Larval stage of crustaceans | |
| b) Larval stage of mollusks | |
| c) Live algal feed | |
| d) Larval feed / Live feed - rotifer / <i>Artemia</i> nauplii | |
| 5. Record + Viva-voce | 6+4 = 10 M |

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Four-year B.Sc.

Domain Subject: **FISHERIES**

IV Year B.Sc. –Semester-V

Course 6B: **AQUATIC POLLUTION AND COASTAL ZONE 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. Understand the sources and classification of water pollution.
2. Acquaint with the types of aquatic pollution.
3. Familiarize with the aquatic microbes and their pollution and EIA.
4. Know the resources of coastal ecosystems, remote sensing and GIS for coastal management.
5. Comprehend the methods of coastal management, CRZ Act, ICZM and international treaties and conventions.

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

Unit-1: Classification and Source of aquatic pollution (10h)

1. Definition of pollution; Classification of pollution – Physical, chemical and biological classification of water pollution- description. Point and non-point source of pollution.
2. Sewage and domestic wastes: Composition, pollution effects, sewage treatment and reuse
3. Agricultural wastes: Organic detritus, nutrients; Adverse effects of oxygen demanding wastes: Importance of dissolved oxygen, Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills.

Unit-2: Types of water pollution (10h)

1. Pesticide pollution: Types and categories; Organochlorine compounds; Organophosphorous compounds; Polychlorinated biphenyls (PCBs); Biomagnification - Bioaccumulation and impact on aquatic fauna and human health.
2. Heavy metal pollution: Interaction of heavy metals with water and aquatic organisms, their ill effects. Oil Pollution: Crude oil and its fractions; Source of oil pollution; Treatment of oil spills at sea; Beach cleaning; Toxicity of petroleum hydrocarbons; Ecological impact of oil pollution - case studies.
3. Thermal pollution and its effects. Radioactive pollution: Radioactive wastes and special effects of radioactive pollution. Physical and chemical nature of possible effluents from major industries.

Unit-3: Microbiological pollution and EIA (10h)

1. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage fungus complex; Transmission of human

pathogenic organisms; Zoonosis; Development of antibiotic resistance and its impact; Biofilms and Biocorrosion.

2. Monitoring and Control of pollution: Biological indicators of pollution in natural waters; Solid waste management; Bioremediation; Phytoremediation; Advanced waste treatment measures; Pollution control boards.
3. Environmental Impact Assessment (EIA) for fisheries and aquaculture projects. Anthropogenic activities and their impact on coastal zones - aquaculture, waste disposal, property and infrastructure development, ports and shipping, tourism (beach and coral reef), industries (petroleum industry, heavy metal industry, forest industry), mining and marine excavations, water supply projects.

Unit-4: Coastal Zone Management (CZM) (10h)

1. Coastal Ecosystems: Estuaries; Wet lands and Lagoons; Living and non-living resources. Goals and purposes of CZM.
2. Remote sensing: Principles of remote sensing; Remote sensing for coastal management.
3. Geographical Information System (GIS): Definition; Concepts; Applications of GIS in aquatic resource identification.

Unit-5: CZM methods, CRZ and ICZM (10h)

1. Management methods and information: public awareness and environment policy, general coastal zone programs, shore lands management, coastal water basin protection, coastal water quality protection, harvestable resources, and ecosystem restoration.
2. Coastal Regulation Zone (CRZ) Act.
3. Integrated Coastal Zone Management (ICZM). International treaties and conventions.

Practical Syllabus: Course 6B: Aquatic Pollution and Coastal Zone Management

III. Skills Outcomes:

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

1. Acquire skills in analyzing water, sediment and microbes in polluted water bodies.
2. Assess the quality and quantity of bacteria in polluted waters.
3. List out and identify the bacteria, flora and fauna as indicator species of aquatic pollution.
4. Acquaint with different types of pesticides and their pollution.
5. Demonstrate the procedure of preparing EIA, Coastal projects and Coastal zone mapping.

IV. Practical Syllabus:

1. Physical characteristics of polluted waters; Colour, Odour, Turbidity.
2. Water analysis: Determination of pH, salinity, alkalinity, hardness, BOD, COD, hydrogen sulphide, phosphates, ammonia, nitrates, heavy metals and oil and grease.
3. Sediment analysis: Determination of pH, conductivity, organic carbon, nitrogen and phosphorus.
4. Study of pathogenic and coliform bacteria.
5. Bacteriological quality of water: Colliform tests, IMViC test, standard plate count.
6. Methods of enumerating bacterial biomass in waters and waste waters.
7. Pollution flora and fauna: indicator species- algae, protozoa and insect larvae.

8. Pesticide pollution: Acquaintance with different types of pesticides; Warning pictograms and symbols. Methods of pesticide residue analysis in waters and fish tissues; Bioassay and toxicity study.
9. Study on coastal living resources; and Coastal zone mapping.
10. Project preparation of EIA.
11. Preparation of projects based on the provided Guidelines and Standards for Coastal Projects- aquaculture, agriculture, estuarine flood protection, sewage treatment systems, solid waste disposal, urban runoff, Power plants, disasters, etc.

V. References:

1. Chhatwal, G.R., M.C. Mehra, T. Katyal, M. Satake, Mohan, K. and T. Nagahiro. (1995). Environmental Water Pollution and its Control. Anmol Publications Pvt. Ltd., New Delhi.
2. Edward A. Laws (1993). Aquatic Pollution. 2nd Edn. Wiley Interscience, John Wiley & Sons Inc., New York.
3. APHA. (1995). Standard Methods for the Examination of Water and Wastewater. 19th Edition, American Public Health Association, Washington.
4. Clark, R.B. (1994). Marine Pollution. Clarendon Press, Oxford.
5. Hynes, H.B.N. (1978). The Biology of Polluted Waters. Liverpool University Press, UK.
6. Subba Rao, M.V. (1998) .A Manual of Practical Methods in Environmental Science. Andhra University, Visakhapatnam.
7. Brahtz, JFP. (1972). Coastal Zone Management. UN Department of International Economic & Social Affairs, New York.
8. Cairns, J Jr. (1994). Implementing Integrated Environmental Management. Virginia Tech. University.
9. Clark, JR. (1992). Integrated Management of Coastal Zones. FAO Fisheries Tech. Paper No. 327, Rome.
10. Coastal Area Management and Development (1982). UN Department of International Economic & Social Affairs, New York.
11. *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 analysis of water and sediment samples collected from polluted water bodies; qualitative and quantitative estimation of pathogenic and coliform bacteria, studying pollution indicator species, analyzing various aspects on pesticide pollution, studying coastal living resources and preparation of projects on EIA and other coastal projects.
2. **For Student:** Individual visit to Industrial and other pollution affected water bodies/ Effluent Treatment Plant Unit/ different coastal environments/ university/ research organization and study the water pollution and coastal zone management. 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 pollution assessment and their handling, operational techniques with safety and security, and tools for Coastal zone mapping).
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in pollution and CRZ studies.
5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visits to study the water bodies polluted with various pollutants, Dist. Pollution Control Board office, research organizations on pollution studies, remote sensing, GIS, CZM, 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/ Fisheries Course – 6B (Skill Enhancement Course)
Aquatic Pollution and Coastal Zone Management

Max. Time : 3 Hours

Max. Marks : 50

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| 1. Determination of a polluted water parameter ‘A’ | 8 M |
| 2. Estimation of a sediment parameter ‘B’ | 8 M |
| 3. Demonstration of EIA / coastal project / coastal zone mapping ‘C’ | 12 M |
| 4. Identification, salient features and importance of the following. | 4 x 3 = 12 M |
| a) Pollution indicator species | |
| b) Warning pictogram and symbol of a pesticide | |
| c) Coastal finfish/ shellfish | |
| d) Coastal mangrove/ algae/ other invertebrate/ vertebrate | |
| 5. Record + Viva-voce | 6+4 = 10 M |

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Four-year B.Sc.

Domain Subject: **FISHERIES**

IV Year B.Sc. – Semester-V

Course 7B: **ORNAMENTAL FISHERIES**

(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 the global and Indian status of ornamental fisheries
2. Identify various commercially important freshwater and marine ornamental fishes
3. Demonstrate skills for breeding and larval rearing of ornamental fishes
4. Construct, set up and maintain the freshwater and marine aquaria for fish keeping
5. Understand the ornamental fish trade regulations and wildlife act, and establishment of breeding and culture units for commercial production of ornamental fishes.

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

Unit-1: Status of Ornamental fisheries (10h)

1. World trade of ornamental fish and export potential.
2. Present status and scope of ornamental fish farming and trade in India. Indian ornamental fish diversity and its status.
3. Types of aquaria - Home and public aquaria (freshwater and marine), oceanarium.

Unit-2: Freshwater Ornamental Fishes (10h)

1. 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.
2. Brood stock management; breeding and larval rearing. Larval feeds and feeding. Application of genetics and biotechnology for quality strain production.
3. Freshwater plants – their taxonomy and morphology, and propagation methods.

Unit-3: Marine Ornamental Fishes (10h)

1. Marine ornamental fishes–varieties and their habitats. Other ornamental organisms – anemones, worms, lobsters, shrimps, octopus, starfish. Reef aquarium and live rocks.
2. Major marine ornamental fish resources of India. Method of collection of live fish. Use of anesthetics.
3. Breeding of marine ornamental fishes (clown and damsel fishes) and larval rearing.

Unit-4: Aquarium fish keeping (10h)

1. Fabrication, setting up and maintenance of freshwater and marine aquarium - Lighting and aeration - Aquarium plants - Aquarium accessories and decoratives.
2. Water quality management for freshwater and marine aquariums. Water filtration system –

biological, mechanical and chemical. Types of filters.

3. Aquarium fish feeds – Live feeds, Dry and wet feeds. Pigmented feeds for colour enhancement.
4. Common diseases of aquarium fish – diagnosis and treatment. Control of snail and algal growth. Medicines and chemicals used in aquaria.

Unit-5: Ornamental fish trade (10h)

1. Fish conditioning, packing, transport and quarantine methods.
2. Trade regulations and Wildlife act in relation to ornamental fishes.
3. Prerequisites for the establishment of ornamental fish breeding and culture unit for entrepreneurship development. Socio-economic upliftment of women through ornamental fish farming.

Practical Syllabus: Course 7B: Ornamental Fisheries

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 doses.
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 & IBHPublishing.
 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 a laboratory and field for a total of 15 hours on the varieties of freshwater and marine ornamental fishes and their biology, setting up and maintenance of aquaria for fish keeping, packing, transport and trade 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/ Fisheries Course – 7B (Skill Enhancement Course)
Ornamental Fisheries

Max. Time : 3 Hours

Max. Marks : 50

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|---|--------------|
| 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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Four-year B.Sc.

Domain Subject: **FISHERIES**

IV Year B.Sc. – Semester-V

Course 6C: **FISHERIES EXTENSION EDUCATION**

(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 the concept of fisheries extension education and Fisheries training institutes and research organizations in India.
2. Acquaint with the methods of educating the fishermen and farmers on fisheries extension
3. Demonstrate the transfer of technology programs in fisheries
4. Understand the rural sociology and educational psychology
5. Execute the planning and evaluation of extension programs.

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

Unit-1: Introduction

(10h)

1. Extension Education: Concepts, objectives and principles - formal and informal education.
2. History and role of fisheries extension in fisheries development.
3. Fisheries training and Education in India: Training Institutes, Universities, Research organizations.

Unit-2: Fisheries extension methods

(10h)

1. Individual, group and mass contact methods and their effectiveness, factors influencing their selection and use.
2. Audio visual aids – definitions, advantages and disadvantages.
3. Classification and choice of audio visual aids. Criteria for selection and evaluation of audio visual aids.

Unit-3: Transfer of Technology

(10h)

1. Characteristics of technology and Process of transfer of technology. Important TOT Programs in fisheries. ICAR programs – salient features of ORP, NDS, LLP, IRDP, ITDA, KVK, FFDA, FCS, FTI, TRYSEM.
2. DAATT centers and their role in TOT programs, video conferencing, educating farmers through print and electronic media.
3. Adoption and diffusion of innovations and process, barriers in diffusion of fisheries innovations. Role of BFDA, FFDA, MPEDA, CAA, NGOs and SHGs in Fisheries. Fisheries co-management.

Unit-4: Rural Sociology and Educational Psychology (10h)

1. Basic concepts in rural sociology and psychology and their relevance in fisheries extension.
2. Social change, social control, social problems and conflicts in fisheries. Gender issues in fisheries. Theories of learning, learning experience and learning situation.
3. Village institutions and Voluntary organizations - their role in fisheries and aquaculture development.

Unit-5: Extension Program Planning and Evaluation (10h)

1. Steps in Extension Program Planning and Evaluation and its importance; Participatory planning process.
2. Programs for weaker section of the community.
3. Fishery development plans and various schemes, Fish Farmer's Development Agencies and their achievements.

Practical Syllabus: Course 6C: Fisheries Extension Education

III. Skills Outcomes:

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

1. Execute various audio-visual aids.
2. Conduct meetings and surveys on social and gender issues.
3. Organize audiovisual programs on fisheries extension
4. Know the role of formal and non-government organizations in fisheries extension
5. Assess the developmental needs of the fishermen community.

IV. Practical Syllabus:

1. Preparation and use of audio-visual aids in fisheries extension.
2. Preparation and use of non-projected visual aids in fisheries extension.
3. Preparation and use of projected aids in fisheries extension.
4. Preparation and presentation of radio script and television talk.
5. Study of social issues/problems through participatory and rapid rural appraisal techniques, stake holder's analysis and needs assessment.
6. Assessment of the developmental needs of community.
7. Role of formal and non-governmental organizations through Stake holder analysis.
8. Case studies on social/ gender issues and social conflicts in fisheries.
9. Case studies on extension programs and success stories.
10. Practical exercises on conducting/demonstrating different fish farmers meetings.

V. References:

1. Chauhan, N.B, Patel, B.S and Patel R.C(2007) Fundamentals of Extension Education, Department of Extension Education, B.A.College of Agriculture, AAU, Anand.
2. Adivi Reddy A. (2001). Extension Education, Sree Laxmi Press, Bapatla, A.P.
3. Supe, S.V. (1997). An Introduction to Extension Education. Second Edition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Ray, G.L. (2017). Extension Communication and Management. Naya Prakashan, Kolkata
5. Chitambar, J.B.(1990). Introductory Rural Sociology. Wiley Eastern Ltd., NewDelhi.
6. Pandey, S.K. (1997). Teaching Communication. Common Wealth Publishers, New Delhi.

7. Dahama OP and Bhatnagar, OP (2019). Education and Communication for Development, Oxford and IBH Co, New Delhi.
8. *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 preparation and use of audio-visual, non-projected and projected aids for fisheries extension, preparation of radio script and television talks; demonstrating the role of formal and non-governmental organizations for fisheries and aquaculture development, etc.
2. **For Student:** Visit to fishermen communities, conduct individual and group meetings and survey on social/ gender issues and social conflicts in fisheries, organize meetings for fishermen and farmers on TOT programs and demonstrate the fisheries extension programs of government and voluntary organizations by audiovisual programs using projected and non-projected aids. 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 TOT programs and case studies on extension programs and social/gender issues)
3. Seminars, Group discussions, Quiz, Debates, etc. (on related topics).
4. Preparation of videos on extension program meetings.
5. Collection of material/figures/photos related to the topic, writing and organizing them in a systematic way in a file.
6. Visit to CIFE, MPEDA, ICAR, SIFT, CIFT, State Fisheries Department, NGOs, 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/ Fisheries Course – 7C (Skill Enhancement Course)
Fisheries Extension Education

Max. Time : 3 Hours

Max. Marks : 50

- | | |
|---|--------------|
| 1. Audio-visual aids ‘A’ | 8 M |
| 2. Projected / Non-projected aids ‘B’ | 10 M |
| 3. Social/ gender issues in fisheries ‘C’ | 10 M |
| 4. Demonstration of role of formal and non-governmental organizations ‘D’ | 12 M |
| 5. Record + Viva-voce | 6 + 4 = 10 M |

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Four-year B.Sc.

Domain Subject: **FISHERIES**

IV Year B.Sc. – Semester-V

Course 7C: **MICROBIOLOGY OF FISH AND FISHERY PRODUCTS**

(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 the history and significance of microorganisms in fish foods
2. Understand the microorganisms in fish foods, the factors affecting the microbial growth and their role in food spoilage.
3. Acquire knowledge on microbes involved in foodborne infections and intoxications
4. Ascertain the various types of fish spoilage and its control
5. Maintain the seafood safety and quality in fish processing industries.

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

Unit-1: Introduction to microbiology (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. Conventional and rapid techniques for the detection of microorganisms in food.

Unit-2: Fish microbiology (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. Intrinsic and extrinsic parameters that affect microbial growth in fish.
3. Psychrophiles, halophiles and thermophiles, their role in spoilage and food poisoning.

Unit-3: Foodborne pathogens (10h)

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

Unit-4: Fish spoilage (10h)

1. Types of spoilage of fish and fishery products. Indicators/Indices of fish spoilage.
2. Microbial spoilage of fish/shellfish. Control measures to reduce microbial load in fish and fishery products.
3. Assessment of fish spoilage and Limiting spoilage

Unit-5: Seafood safety and quality management (10h)

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

Practical Syllabus: Course 7C: Microbiology of Fish and Fishery products

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.
9. Burgess, et al. (1982). Fish Inspection and Quality Control. Fishing News Books Ltd., UK.
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 Wiley-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 significance of microbes in fish and fish products, microbial principles of fish preservation and processing, foodborne pathogens of public health concern, microbial fish spoilage, seafood safety 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 management 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)

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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.	
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Suggested Question Paper Model for Practical Examination

Semester – V/ Fisheries Course – 7C (Skill Enhancement Course)

Microbiology of Fish and Fishery products

Max. Time : 3 Hours

Max. Marks : 50

- | | |
|---|--------------|
| 1. Sterilization techniques/ Staining techniques ‘A’ | 8 M |
| 2. Preparation of microbiological media / Organoleptic evaluation of fish ‘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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