Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara

(Autonomous)

Lead College of Karmaveer Bhaurao Patil University, Satara

Reaccredited by NAAC with 'A+' Grade

Syllabus For

Bachelor of Science

Fisheries

Syllabus to be implemented w.e. f. June 2023

(As per NEP 2020)

Syllabus for B.Sc. II Fisheries

PREAMBLE:

1. To impart the knowledge of animal science to the pupils.
2. To make the pupil to use the knowledge in their daily life
3. To make the pupil aware of natural resources and environment
4. Application of knowledge in Fisheries for nutrition Aquaculture practice.
5. To provide practical experiences which form the part of their learning processes.
6. To develop aptitude for scientific work and ability to pursue studies far beyond graduation
7. To encourage the pupil to take life science as a carrier which is the need now a day
8. To make the pupil fit for the society

IV) General Objectives of the course:

1. To impart the knowledge is the basic aim of education. The students are expected to acquire the knowledge of animal science, natural phenomenon, manipulation of nature and environment by man.
2. Understanding the scientific terms, concepts, facts, phenomenon and their interrelationships.
3. Applications of the knowledge
4. To develop skills in practical work, experiments and laboratory materials, instruments
5. To develop interest in the subject and scientific hobbies
6. To develop scientific attitude which is the major objective, this makes the students open minded, critical observations, curiosity, thinking etc.
7. Abilities to apply scientific methods, collection of scientific data, problem solving, organize science exhibitions, clubs etc.
8. Appreciation of the subject, contribution of the scientists, scientific methods, scientific programmes

Class	Level	Sem	Subject-1		Subject-2		VSC	SEC	AEC	VEC	CC	Total
			Major		Minor							
			T	P	T	P						
B. Sc. II	5.0	III	4	4	2	2	2	2	4	2	__	22
		IV	4	4	2	2	2	2	4	__	2	22

Semester	Course	Course Title
III	Major	Fishery Biology I
		Inland Fishery I
	Minor	Inland Fisheries Resources Management
	Vocational Skill courses	Fresh Water Aquaculturist
	Skill Enhancement Course	Fish Seed Grower
IV	Major	Aquaculture-II
		Fish Biology and Harvest Technology
	Minor	Marine Fisheries Resources Management
	Vocational Skill courses	Ornamental Fish Breeding
	Skill Enhancement Course	Hatchery Manger

Semester – I

Major Course

Course – I: BFT- 301

Course Objectives: Students Should be able to…

1. Students are introduced to brief history of Fisheries regarding capture and culture fisheries in Inland and Marine waters, various activities like: i. Fishing. ii. Processing iii. Marketing & Food, Feeding and Growth of Shell and Fin Fishes.
2. Students should able to learn morphology of mollusc, cartilagenous fish, bony fish, typical lung fish and internal anatomy of typical cartilagenous fish.
3. Students should able to learn internal anatomy of typical bony fish and economic importance of some important fin and shell fish.
4. Students should be aware of important general topics that is study of predatory fish, swim bladder, lung fishes etc

Credits **(Total Credits 2)**	**Semester – I** **Course – I: BFT- 301: FISHERY BIOLOGY I**	**No. of hours per unit**
Unit – I	**Fisheries and Food, Feeding and Growth of Shellfish** 1.1 An Introduction to Fisheries 1.2 Importance of fisheries. 1.3 Natural food, feeding habits, feeding intensity utilization of food, gut content analysis. 1.4 Digestive system of shrimp, crab and molluscs. 1.4 Integument and exoskeleton of crustaceans, their structure and functions.	**(08)**

Unit – II	**External Morphology of :** 2.1 Bivalve- Unio. 2.2 Typical cartilaginous fishes - Scoliodon 2.3 Typical bony fish- Labeo **Internal Anatomy of Fin fish :Scoliodon** Concerning – 2.4 Digestive system 2.5 Circulatory system 2.6 Excretory and reproductive system 2.7 Brain	**(06)**
Unit – III	**Internal Anatomy of Fin fish :Labeo** 3.1 Digestive system 3.2 Circulatory system 3.3 Excretory 3.4 reproductive system 3.5 Nervous System- Central Nervous system 3.6 Economic importance of the following: Prawn, Unio, Oyster, *Scoliodon*, *Harpodon*, Pomphret, Sardine, *Labeo* and *Catla*	**(08)**
Unit – IV	**Study of the following general topics :** 4.1 Identification of predatory and weed fishes. i) Predatory fishes – Wallago attu, Anabus, Ophiocephallus. ii) Weed fishes – Punctius, Aplocheilus, Rosbora 4.2 Swim bladder- Tyes and Functions 4.3 Lung Fishes. 4.4 Hill stream adaptation in fishes. 4.5 Parental care in fishes 4.6 Adaptation in Exotic Fishes.	**(08)**

Course Outcomes: Students will be able to…

1. Learn the history and importance of fisheries and acquire knowledge regarding fisheries activities such as fishing, processing, and marketing in Inland and Marine waters.

2.Understand aware of taxonomy, general characters and outline of the classification of shell and fin fishes using a standard key.

3. Recognize molluscs, cartilagenous and bony fish by observing external morphological peculiarities.

4. Learn the internal anatomy of typical cartilage and bony fish.

5. acquire the knowledge of economic importance of fin and shell fish.

6.Understand knowledge regarding different types of Predatory fishes, swim bladders, lung fishes, parental care and adaptation in fish.

Reference Books:

1. Fish and Fisheries of India : V. G. Jhingran. Hindustan Publication Corp. (India), Delhi(Unit I)

2. Tropical Fish Farming : D. K. Belsare. Environmental Publi. Karad, Maharashtra (Unit I)

3. Aquaculture : J. E. Bardach. J. H. Ryther and W. O. McLarney (Unit I)

4. Encyclopaedia of Fishes and Fisheries of India. A. K. Pandey. G. S. Sandhu Vol. IV. Anmol. Publi. New Delhi. (Unit I)

5. An Introduction to Fishes : S. S. Khanna. Central Book Depot. Allahabad (Unit I, II, III, IV)

6. Vertebrate Z oology -Kotpal R.L. (Unit II, III)

7. Vertebrate Zoology- J.Z.Young (Unit II, III)

8. Chordate Zoology- Dhami and Dhami. (Unit II, III)

9. A Textbook of Fishery Science and Indian Fisheries : C. B. Shrivastav. Kitab Mahal, New Delhi.(Unit III)

B. Sc. II Semester I

BFP-301 -Practical Course I

Course Objectives: Students should be able to…

1. classification of freshwater& marine water fin fish.

2. memorized freshwater& marine water shellfish.

3. describe different types of adaptations in fish.

4. demonstrate of different systems from dissected bony fish.

Credits (Total Credits 2)	Semester-I BFP-301- Practical Course I (Based on BFT-301)	No. of hours per Practical
1.	Identify and describe predatory fishes (any three).	**4**
2.	Study of the Digestive System of Shrimp	**4**
3.	Study Exoskeleton of crustaceans	**4**
4.	Identify and describe predatory fishes (any three).	**4**
5.	**Morphology of following** a. Morphology of Scoliodon b. Morphology of Labeo c. Morphology of Unio	**4**
6.	Study of Swim Bladder	**4**
7.	**Economic importance of the following:** Prawn, Unio, Oyster, *Scoliodon*, *Harpodon*, Pomphret, Sardine, *Labeo* and *Catla*	**4**
8.	**Internal Anatomy of Fin fish :Scoliodon** 5.1 Digestive system	**4**
9.	5.2 Circulatory system 5.4 Brain	**4**

10.	5.3 Excretory and Reproductive System	**4**
11.	Identification and taxonomical classification of teleosts and crustaceans	**4**
12.	Study of Lung fishes	**4**
13.	Study of Hill stream adaptation in fishes	**4**
14.	Study of Adaptation in Exotic Fishes	**4**
15.	Parental care in fishes	**4**
16.	Identification of crustaceans	**4**
17.	Identification of Shell fishes	**4**
18.	Study of Aquarium Shell fishes	**4**
19.	Survey on Shell fishes	**4**
20.	Project: Visit to fish market	**4**

Course Outcomes: Students will be able to…

1. classify any given fish

2. describe adaptations in fish.

3. sketch different systems of fish.

4. distinguish between different types Shell fish and fin fish.

Reference Books:

1. Fish and Fisheries of India : V. G. Jhingran. Hindustan Publication Corp. (India), Delhi **(Unit I)**
2. Ecology - P.D. Sharma **(Unit I)**
3. A Textbook of Fishery Science and Indian Fisheries : C. B. Shrivastav. Kitab Mahal, New Delhi **(Unit I)**
4. A Manual of Freshwater Acquaculture : R. Santhanam. N. Sukumaran and P. Natrajan. **(Unit II)**
5. An Introduction to Fishes : S. S. Khanna. Central Book Depot. Allahabad. **(Unit II,III)**
6. Manual of Methods in Fish Biology : S. P. Biswas. **(Unit II,IV)**
7. Manual in Fishery Science : K. R. Reddy and M. G. Babare. **(Unit II)**
8. Fishery technology – Balachandran **(Unit IV).**

Course - II: BFT- 302 (Inland Fisheries)

Course Objectives: Students Should be able to…

1. Students should be introduced to different types of fresh water habitats with reference to food chain, food web and primary productivity.
2. Students should learn about activities in Inland riverine, reservoir, lacustrine capture fisheries.
3. Students should study phytoplankton, Zooplankton, benthos, Nektons etc.
4. Students should learn different fish preservation and processing techniques**.**

Credits (Total Credits 2)	Semester – I Course - II: BFT- 302 (Inland Fisheries)	No. of hours per unit
Unit – I	1.1 Freshwater fishery regions of the world and their major fish species composition. 1.2 Global inland fish production data. 1.3 Inland capture fishery resources of India. 1.3 Potential of inland waterbodies with reference to respective state. 1.4 Problems in the estimation of inland fish catch data. 1.5 Major riverine and estuarine systems of India. 1.6 Major lakes and their fisheries. 1.7 Differences between man-made and natural lakes and flood-plain wetlands as capture fishery resources, present status of their exploitation and future prospects. 1.8 Cold water fisheries of India.	**(08)**
Unit – II	3. Inland Capture Fisheries: 3.1 Riverine capture fisheries. 3.2 Reservoir capture fisheries. 3.3 Lacustrine capture fisheries	**(06)**
Unit – III	**3.1 Plankton:** Planktonic organisms; Classification of plankton; Distribution of plankton: geographic, vertical, horizontal, and seasonal distribution of phytoplankton and zoo-plankton; Seasonal changes of body form in planktonic organisms; Food of planktonic organisms; Primary and secondary productivity; Chemical composition of plankton**.**	**(08)**

	3.2 Hydrophytes: free-floating, rooted with floating leaves, Submerged, Rooted Submerged, Rooted emergent hydrophytes **3.3 Nekton:** Composition; Distribution; Movements. **3.4 Benthos:** Classification; Zonation; Distribution; Movements and migrations; Seasonal changes in benthos; Peri1phyton; Profundal bottom fauna	
Unit - IV	**Problems and Management of world inland fisheries resources** 4.1 Introduction page 4.2 Under estimation of inland 4.3 Sharing inland fisheries resources with other 4..4 Transboundary 4.5 Multi-gear and Multi-species 4. 6 Improper and insufficient data collection 4.7 Non-availability of network of fisheries 4. 8 Overfishing 4.9 Issues of implementation of fisheries legislation	**(08)**

Course Outcomes: Students will be able to …

1. describe the different inland water system.
2. Explain different capture fisheries .
3. discuss names of phytoplankton, Zooplankton, nekton, benthos in water system.
4. compare fish preservation techniques.

Reference Books:

1. Khanna S. S and Kapoor N. (2019): An Introduction to fishes. Surjeet Publications. Central Book Depot, Allahabad.
2. Pandey A. K and Sandhu G.S (2014): Encyclopedia of fishes and fisheries of India Vol. I and IV, Amol Publication, New Delhi.
3. Khanna S. S and H. R. Singh (2003): A text book of fish biology and fisheries, Narendra Publishing House, New Delhi.
4. Jobling, M. (1995). Environmnetal biology of fishes, Chapman and Ha Joachim W. Hertrampf.
5. King, M.,(1995). Fisheries Biology, Assessment and Management. Fish News Book, Blackwell Science, Inc. Cambridge, MA.
6. Jhingran. V G. (1991). Fish and Fisheries of India, Hindustan Publishers.
7. Lagler, K.P. Berdach, J.C. Miller, R.R and Passion M., D.R.(1977). Ichthyology. John Wiley and sons inc. Newyork.
8. Matty, A.J. (1985). Fish endocrinology (Croom Helm, Ltd. U.S.A. 267 p 23.
9. Mcvey J.P., (1983): Handbook of Mariculture, CRC press, Florida

10. Norman J. R: A. (1963) of Fishes. Earnest Benn. Ltd. London. Second Edition

B. Sc. II Semester I

BFP-302 -Practical Course II

Course Objectives: Students should be able to…

1. classification of different types of planktons.

2. memorized Inland resoures

3. label different types of fins & scales in fish.

4. demonstrate of different systems from dissected bony fish.

Credits (Total Credits 2)	Semester-I BFP-302- Practical Course II (Based on BFT-301)	No. of hours per Practical
1.	Studies of geographical location of major Inland water bodies of India.	**4**
2.	Collection and identification of freshwater phytoplankton.	**4**
3.	Enumeration and biomass estimation of freshwater phytoplankton.	**4**
4.	Collection and identification of freshwater zooplankton	**4**
5.	Enumeration and biomass estimation of freshwater zooplankton.	**4**
6.	Collection and identification of benthos from lakes/ponds/ streams / canals.	**4**
7.	Collection and identification of aquatic plants from different freshwater bodies.	**4**
8.	Enumeration and biomass estimation of benthos from lakes/ponds/streams/canals	**4**
9.	Collection and identification of nekton / aquatic insects from freshwater bodies.	**4**
10.	Study of Major carps (Any Three)	**4**
11.	Study of Catfishes (Any Three)	**4**

12.	Study of Other carps (Any Three)	**4**
13.	Study of the major riverine system of India	**4**
14.	Study of the Major Reservoir System of India	**4**
15.	Study of the major Lake system of India	**4**
16.	Study of the Coldwater fisheries of India	**4**
17.	Determination of Phytoplankton and Zooplankton	**4**
18.	Study of Fish Preservation and processing technique	**4**
19.	Survey on Osteichthyes	**4**
20.	Project: Visit to fish market/ visit to Riverine System	**4**

Course Outcomes: Students will be able to…

1. classify any given fish of freshwater.

2. discuss different capture fisheries.

3. Identify different types of nektons.

4. distinguish between different types fish Preservation and processing technique

Reference Books:

1. Jhingram, V.G. Fish and Fisheries of India. Second edition 1983, Hindustan Pub.Co.

Picker, W.E. Methods for assessment of Fish Production in Fresh Waters. Blackwell

Scient. Publ. 1970

2. Bal, D.V. and Veerabhadra Rao, K. Marine Fisheries, Tata MC Grawhill Publications,

New Delhi.

3. Srivastava, U.K. et.al. Freshwater aquaculture in India, Oxford and IBH Publ. Co. New Delhi 1980.

4. C.B.L. Srivastava – A text book of Fishery Science and Indian Fisheries. Kitab Mahal

Agencies, Patna.

5. Fishery technology – Balachandran **(Unit IV)**

Semester -III

BZFT -Minor: Inland Fisheries Resources Management

Course Objectives: Students will be able to,

1. Understand the present exploitation and future potential of inland Fisheries.
2. Learn the methodologies for assessments of Inland Fisheries Resources
3. Identify and evaluate diverse inland fish resources and conservation strategies.
4. Analyse conservation aspects, including biodiversity principles and species management.

Credits-2	**SEMESTER – I** **BFT -Minor : Inland Fisheries Resources Management**	**No. of hours per unit**
Unit – I	**Freshwater fisheries resources in India-** Ponds, Lakes, Bheels, Tanks, **Fisheries Science**: Fisheries Resource Management Wetlands and derelict water bodies their problems and management aspects, Assessment of carrying capacity of different inland water bodies; Water budgeting, Community participation in fishery resource management.	**(08)**
Unit – II	**Riverine fisheries resources in India**: Present trend of dwindling fisheries resources, Direct and Indirect effects of human intervention in rivers, habitat modification and improvement (rehabilitation of channels and flood plains), Protection and restoration of fish movements (different types of fish passes and enhancement of fish migration), Management and repair of riverine vegetation, Stock enhancement strategies like the introduction of new species, Pre- and post-stocking management, Potential risk of stocking.	**(08)**
Unit – III	Reservoir Fisheries in India: Classification of reservoirs, Present productivity levels, Management practices.	**(08)**
Unit - IV	Cold water fisheries of India: Present trends, Problems due to habitat destruction, Management aspects, Prospects of sports fisheries in India.	**(06)**

Course Outcomes: Students should be able to,

1. Analyze global inland fisheries status and trends effectively.

2. Demonstrate knowledge of Inland fish resources and conservation strategies.

3. Apply understanding of fishing methods to diverse inland environments.

4. Evaluate and propose conservation measures for sustainable fisheries management.

Reference Books:

• Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries Chapman and Hall.

• FAO. Technical Papers on Freshwater Fisheries.

• Jhingran VG and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April.

• Jhingran VG and Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.

• Jhingran VG. 1991. Fish and Fisheries of India. 3rd Ed. Hindustan Publ.

• Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House.

SEMESTER – III

Course code : BFP Minor: Practical based on BZFP- Minor

Course Objectives: Students will be able to,

1. assess the status of Inland fisheries globally and identify major fishing nations and regions.
2. evaluate the abundance and distribution of important Inland fish resources, including finfish and shellfish, and understand conservation strategies.
3. determine Physico-Chemical Parameters of Inland water sample
4. analyze variation in Inland freshwater resources.

Credits- 2	**SEMESTER – III** **List of Practical (20)**	**No. of hours (60)**
1.	Identification and Classification of Important Finfish from Freshwater resources.	4
2.	Study of Cold water Fisheries of India	4
3.	Study of catching methods – catch data analysis on major freshwater	4
4.	Biodiversity indices – Gear selectivity.	4
5.	Catch data analysis on marine fishery resources of India.	4
6.	Study Riverine fisheries resources in India.	4
7.	Estimation of the chemical factors from water sample.- Dissolved oxygen	
8.	Estimation of Alkalinity from water sample	4
9.	Estimation of Free carbon dioxide from water sample	4
10.	Estimation of hardness from water sample	4
11.	Determination of primary productivity.	4
12.	Quantitative estimation of plankton	4
13.	Qualitative estimation of zooplankton	4
14.	Study of Reservoir fisheries in India	4
15.	Identification of aquatic weeds and insects	4

16.	Collection and identification of benthos from lakes/ponds/streams/canals.	4
17.	Enumeration and biomass estimation of benthos from lakes/ponds/streams/canals	4
18.	Collection and identification of nekton / aquatic insects from freshwater bodies.	4
19.	Identification of Freshwater ornamental fishes	4
20.	Inland fishery resources – visit to nearest Inland freshwater resources	4

Course Outcomes: Students should be able to,

1. Analyze data and present the status of Inland fisheries worldwide, including major fishing nations and regions.
2. Demonstrate knowledge of important Inland Freshwater fish resources and their conservation strategies.
3. Gain practical experience in different fishing methods used in Inland freshwater fisheries.
4. Apply conservation aspects related to Inland freshwater biodiversity and implement management strategies for sustainable fisheries.

Reference Books:

1.Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries Chapman and Hall.

2. FAO. Technical Papers on Freshwater Fisheries.

3. Jhingran VG and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April.

4.Jhingran VG and Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.

5. Jhingran VG. 1991. Fish and Fisheries of India. 3rd Ed. Hindustan Publ.

6. Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House

Semester-III

B. Sc. II BFT- VSC : Freshwater Aquaculturist

Course Objective: The students should be able to…

1.understand cultivable importance of shellfish and fin fish.

2. remember pre stocking and post stocking management.

3.know the layout of freshwater, brackish, fish and prawn hatecheries.

4. correlate knowledge physico-chemical conditions of water.

Credits (02)	**VSC : Freshwater aquaculturist Practical**	**No. of hours/ Unit**
1.	Cultivable importance of fin fishes.	**4**
2.	Cultivable importance of Shell fishes.	**4**
3.	Design and layout of freshwater farm	**4**
4.	Design and layout of fish and prawn hatcheries.	**4**
5.	Practices on pre stocking management	**4**
6.	Practices on post stocking management	**4**
7.	Analysis of soil sample.	**4**
8.	Estimation and calculation of production cost of fish farm.	**4**
9.	Estimation and calculation of production cost of prawn farm.	**4**
10.	Study of different types of filters.	**4**
11.	Determination of temperature, pH and turbidity.	**4**
12.	Determination of TDS	**4**
13.	Estimation of total alkalinity.	**4**
14.	Estimation of hardness.	**4**
15.	Estimation of dissolved oxygen.	**4**
16.	Estimation of free carbon dioxide.	**4**
17.	Estimation of nitrogen in soil.	**4**

18.	Estimation of organic carbon from soil	**4**
19.	Proper record keeping of the activities	**4**
20.	Visit to farm and hatchery	**4**

Course Outcomes: The students will be able to…

1.explain physico-chemical conditions of water

2.discuss about layout of fish and Prawn hatcheries.

3.discuss methods of production cost of fish and prawn farm

4.Compare and analyze pre stocking and post stocking management.

References Books:

1. Pillay, T. V. R. 1998. Aquaculture Principles and Practices. The Fishing News Books.

2. Rath, R. K. 2000. Freshwater Aquaculture. Scientific Publishers (India) Jodhpur.

3. Piska, R. S. 1999. Fisheries and Aquaculture. Lahari Publications. Hyderabad.

4. Pillay TVR. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambrige University Press, Cambridge.

B. Sc. II BFT- SEC : Fish Seed Grower

Course Objective: The students should be able to…

1.understand the fish seed structure.

2. remember suitable physico-chemical condition to growing seeds.

3.know the developing stages of fish from seed to adult

4. correlate knowledge of proper handling and transportation of seed

Credits (02)	**SEC : Fish Seed Grower Practicals**	**No. of hours/ Unit**
1.	Identification of commercially important fish species for seed Production	
2.	Selection of a suitable pond for seed rearing	
3.	Control of aquatic insects	
4.	Control of aquatic weeds.	
5.	Control of weed and predatory fish	
6.	Proper liming & fertilization	
7.	Management of fish seed (spawn, to fry, Fry to fingerling)	
8.	Brood stalk management	
9.	Handling the mature brooders	
10.	Method of injecting the pituitary exact.	
11.	Collection of spawn ,its transfer to nursery pond or fry product	
12.	Estimation of DO	
13.	Estimation of Co2	
14.	Estimation of hardness	
15.	Estimation of alkalinity	
16.	Maintenance of personal hygiene	
17.	Maintenance of health & hygiene of seed .	
18.	Method of seed transportation	

19.	Proper cleaning & drying of nets, hapas, hand net, canvas bags etc.	
20.	Proper documentation & record-keeping	

Course Outcomes: The students will be able to…

1.explain physico-chemical parameters of water

2.discuss preparation of pituitary extract.

3.discuss methods of transportation and maintenance of fish seed

4.analyze healthy and unhealthy fish seeds.

Reference Books:

1. Huet, M. (1972)Textbook of Fish Culture –Breeding and Cultivation of Fish. Fishing News (Books)Ltd., England.

2. Bardach (1972) Aquaculture–The Farming and Husbandry of Fresh water and Marine Organisms. John Wiley & Sons, NY.

3. Chen,T.P.(1976)Aquaculture Practices in Taiwan. Fishing News (Books) Ltd.,England.

4. TakeoImai.(1977)Aquaculture in Shallow Seas–Progress in Shallow Sea Culture. Oxford & IBH Publ. Co., India.

5. Stickney, R. R.(1979) Principles of Water Aquaculture. John Wiley & Sons, NY.

6. Jhingran, V.G. (1982)Fish and fisheries of India. Hindustan Publ. Corporation (India)

Semester -IV

BFT- 401 : Aquaculture-II

Course Objectives: Students will be able to,

1. Understand aquaculture systems based on water type, economics, design, species, and climate.
2. Recall site selection, pond construction, and the effects of physical, chemical, and biological factors on intensive fish farming.
3. Proficiently manage fish ponds, including pre-stocking tasks like preparation, pest control, liming, and fertilization, as well as stocking, feeding, and harvesting.
4. understand composite and integrated fish farming principles, stocking densities, and the integration with other agricultural practices.

Credits – 2	**SEMESTER – IV** **BFT 401:** Aquaculture-II	**No. of hours per unit**
Unit – I	**UNIT: I** **Importance, objective and scope of aquaculture** · Types of aquaculture: Freshwater aquaculture, brackish water aquaculture and Mari culture. · Culture based on economic or commercial consideration – Extensive, Intensive and Semi-intensive culture. Culture based on types of designs of culture – pond culture, pen culture,cage culture, raceway culture, fish culture in paddy fields. · Culture based on species - Monoculture and Polyculture, · Culture based on climatic condition – Cold water fish culture and warm water fish culture.	**(08)**
Unit – II	**Intensive Fish farming**	**(08)**

	· Selection of site- a) Topography b) Soil type c) Water supply · Construction of fish farm – a) Layout, design and construction of different types of ponds: b) Hatching pits ii) Nursery pond iii) Rearing Pond iv) Stocking pond c) Physical, Chemical and Biological factors affecting fish culture. d) Objectives of fish culture. e) Qualities of cultivable species of fishes. f) Types of cultivable fishes, qualities of major carps. g) Breeding habits of cultivable fishes with special reference to Indian Major Carps.	
Unit – III	**Management of fish pond in fish culture** · **Pre stocking management:** a) Drying the pond, b) Eradication of aquatic weeds c) Eradication of predatory fishes, weed fishes, aquatic insects. d) Liming the pond, e) Pond fertilization ·**Post stocking management** Stocking of fish seed · Supplementary feeding · Harvesting the fish.	**(06)**

Unit - IV	**Composite Fish Farming** : a) Principle and objectives of composite fish farming. b) Composite fish farming in India. c) Stocking density. · Integrated Fish Farming a) Duck cum fish farming. b) Poultry cum fish farming c) Pig cum fish farming. d) Paddy cum fish farming e) Cattle cum fish farming	**(08)**

Course Outcomes: Students should be able to,

1. Identify and classify various types of aquaculture practices based on different criteria such as water type, economic considerations, design, species, and climatic conditions.
2. Analyze the importance, objectives, and scope of aquaculture in the context of various environmental factors, economic considerations, and societal needs.
3. Explain the principles and techniques involved in intensive fish farming to optimize fish production.
4. Demonstrate an understanding of composite fish farming and integrated fish farming systems, including their principles, objectives, and applications

Reference Books:

1. Jhingran, V. G., & Srivastava, R. C. (1983). Fisheries Development in India. New Delhi: Concept Publishing Co.
2. Khanna, S. S., & Singh, H. R. (2003). Textbook of Fish Biology and Fisheries. Delhi: Narendra Publishing House.
3. Khanna, S. S. (Year of publication not provided). An Introduction to Fishes. Allahabad: Central Book Depot.
4. Hilmar Kristjonsonn (Ed.) Vol 1 (1962), Vol 2 (1964) Vol. 3 (1971)

5. Pandey, A. K., & Sandhu, G. S. (Year of publication not provided). Encyclopedia of Fishes and Fisheries of India (Vols. I-IV). New Delhi: Amol Publications.

6. Srivastava, C. B. L. , A Textbook of Fishery Science and Indian Fisheries. Mumbai: Kitab Mahal.

7. Srivastava, R. Impact of Mechanization on Small Fishermen.

8. Subbarao., Mechanization of Marine Fishermen.

9. Jan-Olof- Traung (Ed.) Vol 1 (1955), Vol 2 (1966) Vol. 3 (1967).

SEMESTER – IV

Course code BFP 401: Practical based on BZFT 401

Course Objectives: Students will be able to,

1. Familiarize students with freshwater and brackish water fish species, including their identification, classification, and special features, along with phytoplankton and zooplankton.
2. Provide practical skills in pond layout, design, and construction suitable for fish farming.
3. Enable understanding and application of intensive fish farming techniques, including site selection, pre-stocking pond management, stocking of fish seed, feeding, and harvesting.
4. Introduce concepts of integrated fish farming, allowing students to design and implement sustainable fish farms incorporating multiple components for increased productivity.

Credits (Total Credits 2)	**SEMESTER – IV** **BFP- 401 : Aquaculture-II** List of Practical (20)	No. of hours
1.	Identification, Classification, and description of special features of Fresh Water Fishes cat fish , eel , barbs .	4
2.	Identification, Classification, and description of special features brackish Water Fishes	4
3.	Identification, Classification, and description of special feature of Indigenous (IMC- Rohu, Catla, Mrigal). and exotic carps (Silver Carp) Grass Carp, Tilapia, Common Carp	4
4.	Identification, Classification, and description of special feature of Phytoplankton	4
5.	Identification, Classification, and description of special feature of Zooplanktons.	4
6.	Lay out design and construction of different types of ponds.	4
7.	Study on Site Selection for Intensive Fish Farming	4
8.	Visit potential sites and evaluate them based on topography, soil type, and water supply. Discuss the suitability of each site for intensive fish farming.	4

9.	Demonstration on the layout, design, and construction of different types of ponds suitable for fish farming, including nursery ponds, rearing ponds, and stocking ponds	4
10.	Identify and discuss qualities of cultivable fish species, focusing on major carps suitable for intensive fish farming.	4
11.	Study the breeding habits of cultivable fishes, especially Indian Major Carps, through observation and literature review.	4
12.	Demonstrate pre-stocking pond management techniques such as drying the pond, eradicating aquatic weeds, predatory fishes, weed fishes, and aquatic insects, and liming the pond.	4
13.	Demonstrate various harvesting techniques suitable for different types of fish ponds, ensuring minimal stress to the fish and maximum yield.	4
14.	Investigate successful examples of composite fish farming in India and analyze the factors contributing to their success.	4
15.	Determination of different methods of pond fertilization and their effects on fish production.	4
16.	Practice techniques for stocking fish seed in ponds, considering optimal stocking density and species composition.	4
17.	Design and implement a supplementary feeding regime for fish in rearing ponds. Monitor growth rates and feed conversion ratios.	4
18.	Designing an Integrated Fish Farm incorporating multiple components such as poultry, ducks, pigs, paddy fields, or cattle, and discuss the potential synergies among them for increased productivity and sustainability.	4
19.	Conduct tests to assess physical parameters, chemical parameters and biological factors in fish ponds.	4
20.	Visit and study different integrated fish farming models. Assess the benefits and challenges of each model.	4

Course Outcomes: Students should be able to,

1. Classify, and describe freshwater and brackish water fish species, enhancing their understanding of aquatic biodiversity.
2. Develop skills in pond construction, facilitating effective planning and establishment of fish farming facilities.
3. Demonstrate proficiency in implementing intensive fish farming techniques, contributing to efficient fish production.
4. Apply Designs for implementation of integrated fish farms, considering multiple components to enhance productivity and sustainability.

Reference Books:

1.Hilmar Kristjonsonn (Ed.) Vol 1 (1962), Vol 2 (1964) Vol. 3 (1971).Modern Fishing Gears of the World 3. Fishing News Books Ltd. England.

3. Jhingran and Srivastava (1983) Fisheries Development in India. Concept Publishing. Co. New Delhi, 606p

4. Jan-Olof- Traung (Ed.) Vol 1 (1955), Vol 2 (1966) Vol. 3 (1967). Fishing Boats of the World. Fishing News Books Ltd. England.

6. Subbarao, Mechanization of marine fisherman.

7. Srivastava, Impact of mechanization on small fishermen.

8. Text book of Fish Biology and Fisheries - By S. S. Khanna and H. R, Singh (2003 Ed.), Narendra Publishing House, Delhi – 110006

10. Encyclopedia of Fishes and Fisheries of India – By A. K. Pandey and G. S. Sandhu, Vol I to IV, Amol Publications, New Delhi.

11. A text book of Fishery Science and Indian Fisheries – By C.B.L.Srivastava (Kitab Mahal)

12. An Introduction to Fishes – S. S. Khanna, Central Book Depot, Allahabad.

Semester -IV

BFT- 402 : Fish Biology and Harvest Technology

Course Objectives: Students will be able to,

1. Understand the significance of age and growth studies in fisheries management, including their role in assessing population dynamics and sustainability.
2. Analyze seasonal changes in the morphology and histology of fish testes and ovaries, and interpret their implications for reproductive cycles and spawning behaviors.
3. Interpret traditional and modern fishing gears used in India, including their design, materials, and fabrication techniques, and assess their suitability for different fishing environments and target species.
4. Discuss the mechanization of Indian fishing crafts and assess its impact on fishing efficiency, labor dynamics, and resource utilization.

Credits **(Total Credits 2)**	**SEMESTER – IV** **BFT- 402 : Fish Biology and Harvest Technology**	**No. of hours per unit**
Unit - I	**Growth Studies**: · Length – weight relationship · Age and Growth Studies in Fishes: · Methods of age and growth determination – Tagging, Marking, Scale method, radio carbon uptake method, RNA – DNA ratio method. · Length frequency method. · Factors affecting growth rate in fishes. · Significance of age and growth studies	**(08)**
Unit – II	Maturity and Spawning in fishes: · Sexual dimorphism in fishes.	**(08)**

	· Seasonal changes in testes and ovaries (Morphological and Histological) · Study of oogenesis and spermatogenesis in fishes. · Determination of spawning periodicity by ova diameter method. · Study of Gonado somatic index. · Fecundity in fishes – Methods of estimation of fecundity: i) Volumetric ii) Gravimetric iii) Von Bayers Method	
Unit – III	**Methods of fishing gears-** · Introduction ii) Fishing without gear iii) Wounding gear iv) Line fishing v) Fishing baited springs, fish screens, fish traps. vi) Traditional and modern fishing gears : dip net, cast net, triangular net purse net, drag net gill net, bag net, rampani net, trawls, tuna line fishing. vii) Fishing gear material, viii) Fabrication of nets. ix) Preservation of gears x) Recent development in fishing gears of India.	**(08)**
Unit - IV	**Methods of Fishing Crafts**: Indigenous fishing crafts- Fishing crafts- i) Catameron ii) Masula boat iii) Dugout canoes iv) Out trigger canoes v) Plank built canoes vi) Built up boats	**(06)**

	· Mechanization of Indian fishing crafts. · Selection of boat construction material. · Electronics in fishing industry – i) Echo sounder ii) SONAR	

Course Outcomes: Students should be able to,

1. Demonstrate comprehension of the significance of age and growth studies in fisheries management.

2. Analyze seasonal changes in fish reproductive organs, interpreting their implications for spawning behaviours and reproductive cycles.

3. Evaluate traditional and modern fishing gear designs, materials, and fabrication techniques, determining their appropriateness for various fishing environments and species.

4. Engage in critical discussion regarding the impact of mechanization on Indian fishing crafts, assessing its effects on fishing efficiency, labor dynamics, and resource utilization.

Reference Books:

1. Jan-Olof- Traung (Ed.) Vol 1 (1955), Vol 2 (1966) Vol. 3 (1967).Fishing Boats of the World. Fishing News Books Ltd. England.
2. Subbarao, Mechanization of marine fisherman. Srivastava, Impact of mechanization on small fishermen.
3. Hilmar Kristjonsonn (Ed.) Vol 1 (1962), Vol 2 (1964) Vol. 3 (1971) Modern Fishing Gears of the World 3. Fishing News Books Ltd. England.
4. Text book of Fish Biology and Fisheries - By S. S. Khanna and H. R. Singh(2003 Ed.), Narendra Publishing House, Delhi – 110006
5. FISHES BY Mary chandy
6. Field guide on Fishes of Sahyadri Tiger Reserve Range – By J.A. Johnson, A.Rokade, V.Atkore ,K. Sivakumar, C.Ben (2019)

SEMESTER – IV

Course code BFP 403: Practical based on BZFT 402

Course Objectives: Students will be able to,

1. Understand the morphological features indicative of maturity stages in teleost fish species through observation of scales and fins.
2. Learn to prepare permanent histological slides of the testis and ovary of locally available fish specimens.
3. Gain proficiency in assessing fecundity and spawning season by measuring ova diameter in fish populations.
4. Investigate various factors influencing fish growth rates and understand their implications in fisheries management.

Credits (Total Credits 2)	**SEMESTER – IV** **BFT- 402 : Fish Biology and Harvest Technology** List of Practical (20)	No. of hours (60)
1.	Study of maturity stages in teleosts (any locally available fishes) – Morphological studies (by observing scales and fins)	4
2.	Preparation of permanent histological slides of Testis of any locally available fish.	4
3.	Preparation of permanent histological slides Ovary of any locally available fish.	4
4.	Assessment of fecundity and spawning season by ova diameter measurement in any locally available fish.	4
5.	Study the length-weight relationship in fish populations by measuring specimens' length and weight and plotting a scatter graph to analyze the correlation. (Any 5 species -Min 20 Individuals)	4
6.	Investigate age and growth patterns in fish using methods such as tagging, marking, scale examination, and compare the results obtained.	4
7.	Determination of factors affecting fish growth rates through experimental design and data analysis.	4

8.	Analyze the size distribution of a fish population using the length frequency method and constructing a length frequency histogram.	4
9.	Discuss the significance of age and growth studies in fisheries management, presenting relevant case studies.	4
10.	Examine sexual dimorphism in fish species by comparing external morphological differences between male and female specimens.	4
11.	Document seasonal changes in fish gonads through histological analysis to understand reproductive patterns.	4
12.	Study oogenesis in fish by preparing and observing histological slides under a microscope.	4
13.	Study spermatogenesis in fish by preparing and observing histological slides under a microscope.	4
14.	Determine spawning periodicity in fish populations by measuring ova diameter at regular intervals.	4
15.	Calculate the gonadosomatic index (GSI) to assess the reproductive condition and maturity of fish specimens.	4
16.	Estimate fish fecundity using various methods and compare the results for reliability assessment	4
17.	Introduce different types of fishing gears, demonstrate their fabrication and preservation, and discuss recent advancements in Indian fishing gear technology	4
18.	Identification of fishing crafts of Western Ghats -	4
19.	Visit to nearby fish farm centre	4
20.	Visit to Freshwater systems	4

Course Outcomes: Upon completion of the course, Students should be able to,

1. Identify maturity stages in teleost fish species based on morphological characteristics observed in scales and fins.
2. Demonstrate competence in preparing permanent histological slides of fish testis and ovary for microscopic analysis.
3. Assess fecundity and spawning season in fish populations using ova diameter measurements.

4. Apply a comprehensive understanding of age and growth patterns in fish, factors affecting growth rates, and the significance of these studies in fisheries management through experimental design, data analysis, and case study presentations.

Reference Books:

1. Jan-Olof- Traung (Ed.) Vol 1 (1955), Vol 2 (1966) Vol. 3 (1967).Fishing Boats of the World. Fishing News Books Ltd. England.
2. Subbarao, Mechanization of marine fisherman. Srivastava, Impact of mechanization on small fishermen.
3. Hilmar Kristjonsonn (Ed.) Vol 1 (1962), Vol 2 (1964) Vol. 3 (1971) Modern Fishing Gears of the World 3. Fishing News Books Ltd. England.
4. Text book of Fish Biology and Fisheries - By S. S. Khanna and H. R. Singh(2003 Ed.), Narendra Publishing House, Delhi – 110006
5. FISHES BY Mary chandy
6. Field guide on Fishes of Sahyadri Tiger Reserve Range – By J.A. Johnson, A.Rokade, V.Atkore ,K. Sivakumar, C.Ben (2019)

Semester -IV

BFT Minor : Marine Fisheries Resources Management

Course Objectives: Students will be able to,

1. Understand global marine fisheries status, including major nations and trends.
2. Identify and evaluate diverse marine fish resources and conservation strategies.
3. Learn various fishing methods employed in different marine environments.
4. Analyse conservation aspects, including biodiversity principles and species management.

Credits-2	**SEMESTER – II** **BFT 00 : Marine Fisheries Resources Management**	**No. of hours per unit**
Unit - I	**Status of marine fisheries**: Major fishing nations of the world, Major fishing regions, present trend of marine capture fisheries.	**(08)**
Unit – II	**Marine fish resources:** Important finfish and shellfish resources in demersal and pelagic systems; Conservation strategies.	**(08)**
Unit – III	**Fisheries and fishing methods in open waters**: Inshore fisheries (up to 50 m depth)- Beach Seining, Gillnetting, Handline Fishing, Trawling Offshore fisheries (50-200 m depth) – Longlining, Bottom Trawling, Purse Seining Pelagic fisheries- Pelagic Trawling, Drifting Longlining	**(08)**
Unit - IV	**Conservation aspects:** Marine Biodiversity of selected areas including coral reef conservation, Biodiversity principles, Categorization of species into endangered;	**(06)**

	Indeterminate and extinct varieties- Managing the highly exploited fishery resources.	

Course Outcomes: Students should be able to,

1. Analyze global marine fisheries status and trends effectively.

2. Demonstrate knowledge of marine fish resources and conservation strategies.

3. Apply understanding of fishing methods to diverse marine environments.

4. Evaluate and propose conservation measures for sustainable fisheries management.

Reference Books:

1. Bal, D.V., and Rao, K.V. Marine Fishes of India. 1st Revised ed. Tata McGraw Hill, 1990.
2. Chandra, P. Fishery Conservation, Management and Development. 2007.
3. Daya Publishing House. Fisheries and Aquatic Resources of India.
4. Food and Agriculture Organization (FAO). Technical Papers on Marine Fisheries.
5. Kurian, C.V., and Sebastian, V.O. Prawns and Prawn Fisheries of India. Hindustan Publishing Corporation, 1986.
6. Peter, B.M., and Joseph, J.C. Jr. Fishes: An Introduction to Ichthyology. 4th ed. Prentice Hall, 2000.
7. Samuel, C.T. Marine Fisheries in India. Narendra Publishing House, 1968.
8. Shanbhogue, S.L. Marine Fisheries of India. ICAR, 2000.
9. Yadav, B.N. Fish and Fisheries. 2nd ed. Daya Publishing House, 1997.

SEMESTER – IV

Course code BFP Minor : Practical based on BZFT- 402

Course Objectives: Students will be able to,

5. Understand the status of marine fisheries globally and identify major fishing nations and regions.
6. Learn the abundance and distribution of important marine fish resources, including finfish and shellfish, and understand conservation strategies.
7. Demonstrate proficiency in various fishing methods employed in open waters, including inshore, offshore, and high seas fisheries.
8. Analyze conservation aspects related to marine biodiversity, coral reef conservation, species categorization, and management of highly exploited fishery resources.

Credits-2	**SEMESTER – IV** List of Practical (20)	No. of hours (60)
1	Mapping Major Fishing Regions and Trends in Marine Capture Fisheries	4
2	Identification and Classification of Important Finfish	4
3	Identification and Classification of Important Shellfish	4
4	Length frequency analysis – catching method,	4
5.	Catch data analysis on marine fishery resources of India.	4
6.	Set up /Construction of saltwater aquarium in the laboratory.	4
7.	Maintainenace of water parameter of saltwater aquarium	
8.	Explore factors influencing these trends such as climate change, technological advancements, and policy interventions.	4
9.	Demonstration of Beach Seining Techniques	4
10.	Gillnetting Technique Demonstration and Practice	4
11.	Handline Fishing Demonstration and Practice	4

12.	Trawling Technique Demonstration and Practice	4
13.	Longlining Bottom Technique Demonstration and Practice	4
14.	Pot or Trap Technique Demonstration and Practice	4
15.	Purse Seining Fishing Technique Demonstration and Practice	4
16.	Demonstration of Pelagic Trawling Technique and Practice	4
17.	Classify marine species into categories such as endangered, vulnerable, and least concern based on IUCN Red List criteria, and	4
18.	Study of aquarium economics..	4
19.	Identification of marine ornamental fishes	4
20.	Marine fishery resources – visit to nearest marine landing centres	4

Course Outcomes: Students should be able to,

5. Analyze data and present the status of marine fisheries worldwide, including major fishing nations and regions.
6. Demonstrate knowledge of important marine fish resources and their conservation strategies.
7. Gain practical experience in different fishing methods used in open waters, including inshore, offshore, and high seas fisheries.
8. Apply conservation aspects related to marine biodiversity and implement management strategies for sustainable fisheries.

Reference Books:

1. Bal, D.V., and Rao, K.V. Marine Fishes of India. 1st Revised ed. Tata McGraw Hill, 1990.
2. Chandra, P. Fishery Conservation, Management and Development. 2007.
3. Daya Publishing House. Fisheries and Aquatic Resources of India.
4. Food and Agriculture Organization (FAO). Technical Papers on Marine Fisheries.
5. Kurian, C.V., and Sebastian, V.O. Prawns and Prawn Fisheries of India. Hindustan Publishing Corporation, 1986.
6. Peter, B.M., and Joseph, J.C. Jr. Fishes: An Introduction to Ichthyology. 4th ed. Prentice Hall, 2000.
7. Samuel, C.T. Marine Fisheries in India. Narendra Publishing House, 1968.
8. Shanbhogue, S.L. Marine Fisheries of India. ICAR, 2000.
9. Yadav, B.N. Fish and Fisheries. 2nd ed. Daya Publishing House, 1997.

Semester-IV

B. Sc. II BFT- VSC : Ornamental fish breeding

Course Objective: The students should be able to…

1. know the fundamentals of aquarium fish industry.

2. understand the biological features of aquarium fishes.

3. know the food and feeding habits of aquarium fishes.

4. aware about transportation of fishes.

Credits (02)	**VSC: Ornamental fish breeding** **Practical**	**No. of hours/ Unit**
1.	Identify classify and describe an aquarium fishes (any five).	
2.	Study of breeding in live bearer	
3.	Identify and describe the aquarium accessories with their use and maintains	
4.	Identify and describe hybrid aquarium fishes	
5.	Identify and describe food and its Types	
6.	Identify and describe aquarium plants (any five).	
7.	Study physico-chemical conditions of aquarium	
8.	Setting of aquarium.	
9.	Maintenance of an aquarium.	
10.	Cultivation of some common live food	
11.	Aquarium fish diseases	
12.	Study Breeding habits of aquarium fishes	
13.	Exotic and Endemic species of aquarium fishes	
14.	Packaging and forwarding techniques	
15.	Preparation of artificial feed	

16.	Common characters and sexual dimorphism of Fresh water	
17.	Status and Significance of Ornamental Fish Trade	
18.	Prepare aquarium construction Budget	
19.	Submission of own prepared aquarium	
20.	Visit to an Aquarium.	

Course Outcomes: The students will be able to…

1. Construct an aquarium.

2. Manage the fish diseases.

3. Prepare the proper dosage of different kinds of natural and synthetic fish feed.

4. Properly handle and maintain the aquarium fish

Reference Books:

1. Hand Book of Fresh Water Fishes of India By Beaven C.R. — NarendraPub. House.
2. Fish Biology By C.B.C. Srivastava — Narendra Pub. House
3. Ornamental Fish Culture and Aquarium Management Hardcover —2009
4. A D Kholakia .Goldfish Breeds and Other Aquarium Fishes, Their Care and Propagation: A Guide to Freshwater and Marine Aquaria, Their Fauna, Flora and Management Herman Theodore Wolf(Author)
5. The Complete Book of the Freshwater Aquarium: A Comprehensive Reference Guide To More Than 600 Freshwater Fish and Plants Vincent Hargreaves.

Semester-IV

B. Sc. II BFT- SEC : Hatchery manager

Course Objective: The students should be able to…

1. understand the fish brood stock management
2. remember brackish water and marine water cultured fish
3. know the freshwater and brackish water cultured fish
4. correlate knowledge of proper handling and transportation of seed

Credits (02)	SEC : Hatchery manager Practical	No. of hours/ Unit
1.	Identification of brood stock	
2.	Study of brood stock nutritional requirement	
3.	Study of freshwater cultured fishes.	
4.	Study of brackish water cultured fishes.	
5.	Study of marine cultured fishes.	
6.	Preparation of pond	
7.	Methods of brood stock transportation	
8.	Estimation of dissolved oxygen	
9.	Estimation of free co2	
10.	Estimation of hardness	
11.	Estimation of alkalinity	
12.	Liming of pond	
13.	Manuring of pond	
14.	Fertilization of pond	
15.	Transportation of brood stalk	
16.	Keeping record of hatchery operations	
17.	Preparation of hatchery budget	
18.	Maintenance of health & hygiene of brooders	

19.	Identification of prey & predators	
20.	Effective monitoring of hatchery operations.	

Course Outcomes: The students will be able to…

1.explain physico-chemical parameters of water.

2.discuss preparation of pond.

3.discuss methods of management of hatchery.

4.Compare and analyze prey and predators found in hatcheries.

Reference Books:

1. Day, F. 1981. Fishes of India, Vol.I and Vol. II. William Sawson & Sons Ltd., London.

2. Jhingran, C.G. 1981. Fish and Fisheries of India. Hindustan Publishing Co., India.

3. Maheswari, K. 1993. Common fish diseases and their control. Institute of Fisheries Education, Powakads, M.P.

4. Santhanam,R. 1980. Fisheries Science. Daya Publishing House, New Delhi.

5. Yadav, B.N. 1997. Fish and Fisheries. Daya Publishing House, New Delhi

6. FAO Volumes for fish identification.

7. Bal D.V. and Rao, K.V. 1990. Marine Fisheries of India. Tata McGraw Hill Publishing Co. Ltd., New York.

8. Biswas, K. P. 1996. A Text Book of Fish, Fisheries and Technology. Narendra Publishing House, Delhi.