M.Sc. AQUACULTURE

Department of Fishery Science and Aquaculture
BRANCH - VIII

2024-2025

SRI VENKATESWARA UNIVERSITY: TIRUPATI
SVU COLLEGE OF SCIENCES
MASTER OF SCIENCES
DEPARTMENT OF FISHERY SCIENCE & AQUACULTURE
Re – Structured P.G Programme (CHOICE BASED CREDIT SYSTEM (C.B.C.S), as per NEP – 2020, National Higher Education Qualification Frame Work (NHEQF) And Guidelines Of APSCHE
(WITH EFFECT FROM THE BATCH ADMITTED IN THE ACADEMIC YEAR 2024-2025)
CHOICE BASED CREDIT SYSTEM (C.B.C.S), SYLLABUS ANDSCHEME OF EXAMINATION
(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)
M.Sc., AQUACULTURE

SEMESTER- I

S.No	COURSE	Code	Title of the course	H/W	Credits	SEE	IA	Total Marks
1.	CC	**AQC 101**	**Core Course – 1** -Concepts of Aquatic Ecology	4	4	70	30	100
2.		**AQC 102**	**Core Course – 2 (A)-** Systematics and External Anatomy of Cultivable Organisms	4	3	50	25	75
			Core Course – 2 (B) -Ornamental Fish Culture					
3.		**AQC 103**	**Core Course – 3 (A)** -Fish Nutrition and Water Quality Management	4	3	50	25	75
			Core Course – 3 (B) -Environmental Monitoring and Bio deterioration					
4.	*P	**AQC- 104**	**Practical – I -**Identification and Morphology of Cultivable Organisms	6	2	35	15	50
5.	SOC	**AQC 105**	**Skill Oriented Course – 1 (A)-** Coastal Aquaculture	4	3	50	25	75
			Skill Oriented Course – 1 (B)- Capture Fisheries					
6.		**AQC 106**	**Skill Oriented Course – 2 (A)-** General Principles and Practices of Aquaculture	4	3	50	25	75
			Skill Oriented Course – 2 (B)- Aquatic food safety &Quality Management					
7.	*P	**AQC: 107**	**Practical – II -**Fish Nutrition	6	2	35	15	50
			Total	**36**	**20**	**340**	**160**	**500**
8.	Audit Course	**AQC: 109**	Indian Knowledge Systems – 1	4	0	0	100	**0**

*** Audit Course- Self Study**

- CC (Core Course) – 1st Core Course is mandatory 2nd& 3rd Core Courses Student can choose one from each code
- *SOC (Skill Oriented Courses) – Student can choose one from each code
- * Practical – I relating to 2nd& 3rd Core Courses and Practical – II relating to 1st& 2nd Skill Oriented Courses (SOC)
- Audit Course – Zero Credits but mandatary with only a Pass

SEMESTER- II

S.No	COURSE	Code	Title of the course	H/W	Credits	SEE	IA	Total Marks
1.	CC	**AQC 201**	**Core Course – 4- :** Principles of Aquaculture	4	4	70	30	100
2.		**AQC 202**	**Core Course – 5 (A)-** Physiology of Cultivable Organisms	4	3	50	25	75
			Core Course – 5(B) -Aquaculture Engineering					
3.		**AQC 203**	**Core Course – 6 (A)** -Fresh Water Aquaculture	4	3	50	25	75
			Core Course – 6 (B) -Capture fisheries					
4.	*P	**AQC- 204**	**Practical – III-** Soil and Water Characteristics	6	2	35	15	50
5.	SOC	**AQC 205**	**Skill Oriented Course – 3(A) -** : Fishery Economics, Extension and Environmental Management	4	3	50	25	75
			Skill Oriented Course – 3 (B)- Limnology					
6.		**AQC 206**	**Skill Oriented Course – 4 (A)-**Fish Processing Technology	4	3	50	25	75
			Skill Oriented Course – 4(B) - Pollution and Toxicology					
7.	*P	**AQC: 207**	**Practical – IV -**Physiology of Fin Fish and Shell Fish	6	2	35	15	50
8.	OOTC	**AQC : 208**	Open Online Transdisciplinary Course – 2	--	2	-	100	100
			Total	**36**	**22**	**340**	**260**	**600**
9.	Audit Course	**AQC: 209**	Indian Knowledge Systems – 2	4	0	0	100	**0**

- CC (Core Courses) – 4th Core Course is mandatory and 5th& 6th Core Courses Student can choose one from each code
- *SOC (Skill Oriented Courses) – Student can choose one from each code
- *Practical – III relating to 5th& 6th Core Courses and Practical – IV relating to 3r & 4th Skill Oriented Courses (SOC)
- *Open Online Transdisciplinary Course (OOTC) – Students can choose any relevant course of his / her choice from the online courses offered by government agencies like SWAYAM, NPTEL, ETC.,
- Audit Course – Zero Credits but mandatary with only a Pass

SEMESTER - III

S.No	COURSE	Code	Title of the course	H/W	Credits	SEE	IA	Total Marks
1.	CC	**AQC 301**	**Core Course – 7- :** Microbiology and Fish Pathology	4	4	70	30	100
2.		**AQC 302**	**Core Course – 8 (A) -** Fish Immunology	4	3	50	25	75
			Core Course – 8(B) -Fish Breeding and Hatchery Management					
3.		**AQC 303**	**Core Course – 9 (A)** -Cell Biology and Genetics	4	3	50	25	75
			Core Course – 9 (B) -Bioinformatics In Aquaculture					
4.	*P	**AQC- 304**	**Practical – V-** Microbiology and Fish Diseases	6	2	35	15	50
5.	SOC	**AQC 305**	**Skill Oriented Course – 5 (A) -** Fish Nutrition Technology	4	3	50	25	75
			Skill Oriented Course – 5(B)- Essentials Of Biochemistry					
6.		**AQC 306**	**Skill Oriented Course – 6(A) -** Computer Applications, Information Technology And Biostatistics In Aquaculture	4	3	50	25	75
			Skill Oriented Course – 6 (B) - Aquaculture Biotechnology					
7.	*P	**AQC: 307**	**Practical – VI -**Biotechnology And Biochemical Estimations	6	2	35	15	50
8.	OOTC	AQC: 308	Open Online Transdisciplinary Course - 2	-	2	-	100	100
*	Seminar / tutorials / remedial classes and quiz as part of internal assessment			4	--	--	--	--
	Total			**36**	**22**	**340**	**260**	**600**

- CC (Core Courses) – 7th Core Course is mandatory and 8th& 9th Core Courses Student can choose one from each code
- *SOC (Skill Oriented Courses) – Student can choose one from each code
- *Open Online Transdisciplinary Course (OOTC) – Students can choose any relevant course of his /her choice from the online courses offered by government agencies like SWAYAM, NPTEL, etc.,
- *Practical – V relating to 5th & 6th Core Courses and Practical – VI relating to 5th& 6th Skill Oriented Courses (SOC)

SEMESTER- IV

SL.NO	COURSE	CODE	TITLE OF THE COURSE	H/W	CREDITS	SEE	IA	TOTAL MARKS
1	OOSDC	AQC:401	OPEN ONLINE SKILL DEVELOPMENT COURSES	--	8	--	200	200
2.	PW	AQC :402	PROJECT WORK – Orientation Classes	24	12	300	0	300
*	Conducting classes for competitive exams communication skills UGC/ CSIR and NET/SLET examinations			12	--	--	--	--
			TOTAL	**36**	**20**	**300**	**200**	**500**
			TOTAL SEMESTERS	**144**	**84**	**1320**	**880**	**2200**

*Open Online Skill development Course (OOSDC) – Students can choose any **Two** relevant courses of his / her choice from the online courses offered by governmental agencies like SWAYAM, NPTEL, etc., **to get 8 credits (with 4 credits from each course).**

Note: AQC 402 : PROJECT WORK

Each Student will be under the guidance of a faculty member and the students will put in field-oriented research work which mainly consists of visiting to the field for sample collection, farming in fish and prawn culture, hatcheries, processing units, marketing and aquatic diseases analysing in the laboratory. Data collected is compiled and submitted as a dissertation to the department. During viva – voce the students has to present his/ her work to the panel of examiners. The attendance of the student during project work period is considered were they do in Aqua companies / Industries.

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SEMESTER – I

CORE COURSE - I – THEORY-AQC 101: CONCEPTS OF AQUATIC ECOLOGY

COURSE OBJECTIVES

To enable the students to

1. Understand the concepts of Aquatic Ecology
2. Acquire knowledge on the Characteristics of water and dynamics of Aquatic ecosystem
3. Understand the Aquatic vegetation
4. Acquire knowledge on Energy transfer in the ecosystem

CORE – THEORY

AQC 101 : CONCEPTS OF AQUATIC ECOLOGY

UNIT – I

1.INTRODUCTION: Definition of ecology, organism and environment; features of organism - environment relations; living and non - living environments; the ecosystem or habitat.

2.AQUATIC ECOSYSTEMS :Freshwater ecosystems - Lotic and Lentic ecosystems; Marine ecosystems - oceans and seas, zonation of the seas - rocky, sandy and muddy shores; classification of marine habitat - pelagic, benthic, neritic, oceanic, littoral and abyssal.

UNIT – II

3.PHYSICAL CHARACTERISTICS OF WATER :Light - penetration of sunlight into aquatic media, effect of light on productivity, photoperiodicity in animals; Temperature - annual temperature cycles, thermal stratification of water bodies, thermal optimum, maximum and minimum, water movements, periodic and a periodic current systems; Turbidity - causes, variations and effects.

4.CHEMICAL CHARACTERISTICS OF WATER: Atmosphere and atmospheric gases dissolved in water; Oxygen - oxygen and life, hypoxia, anoxia and hyperoxia, adaptations of animals to varying oxygen tensions; Carbon dioxide - sources of Co_2, its ecological effects; pH or hydrogen ion concentration - its significance. total hardness and total alkalinity

UNIT – III

5.BIOGEOCHEMICAL CYCLES: Nitrogen cycle; phosphorus cycle; sulfur cycle; carbon cycle; trace elements - manganese and copper.

6.ORGANIC MATTER : Aquatic vegetation – zones of aquatic vegetation; Plankton - classification of plankton, factors affecting plankton distribution, plankton counting and sampling; phytoplankton - zooplankton relationship, plankton productivity; Benthos -phytobenthos and zoo benthos.

UNIT – IV

7.PRODUCTIVITY: Concept of productivity – standing crop, rate of production and rate of removal; primary and secondary productivity; classification of water bodies on the basis of productivity.

8.DYNAMICS OF AQUATIC ECOSYSTEM : Principal steps and components – niches, trophic levels and relations; producers, consumers, decomposers and transformers; food chain and food web; pyramid of biomasses; pyramid of numbers; energy transfer in the ecosystem.

SUGGESTED READING :

1. Santhanam, R. 1993. A Manual of Fresh Water Ecology: An Aspect of Fishery Environment. Daya Publishing House, New Delhi.

2. Pillai, N. K. 1993. Marine Biology and Ecology. Daya Publishing House, New Delhi.
3. Reid, G. K. and R. D. Wood. 1976. Ecology of Inland Waters and Estuaries D. Van Nostrand Company.
4. Kormondy, E. J. 1996. Concepts of Ecology. Prentice Hall of India Pvt. Ltd. New Delhi.
5. Cole, G. L. 1954. Text Book of Limnology. The C. V. Mosloy Co.,
6. Odum, E. P. 1996. Fundamentals of Ecology. 3rdEdn. Natraj Publishers, Dehradun.
7. Santhanam, R. and A. Srinivasan. 1994. A Manual of Marine Zooplankton. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Pillai, N. K. 1986. Introduction to Planktonology. Himalaya Publishing House, Mumbai.
9. Balakrishnan Nair, N and D. M. Thampy. 1980. A Text Book of Marine Ecology. Mc Millan Co. of India Ltd.
10. Battish, S. K. 1992. Freshwater Zooplankton of India. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

COURSE OUT COMES

Upon completion of the course, students will be able to

CO1.Understand the Aquatic environment and Aquatic ecosystem.
CO2.Understand the Physical and Chemical Characteristics of water.
CO3.Acquire knowledge on Importance of Biogeochemical cycles
CO4. Describe the Nature of Dynamics of Aquatic Ecosystem

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	1	2	1	1	1	1	1	1	1	1	1
CO2	3	1	1	1	2	1	1	1	1	1	1	2
CO3	3	1	2	1	2	1	1	1	1	1	1	1
CO4	3	1	2	1	2	1	1	1	1	1	1	1

H-High-3, M- Medium-2, L- Low-1

AQC 102: SYSTEMATICS AND EXTERNAL ANATOMY OF CULTIVABLE ORGANISMS

COURSE OBJECTIVE

To enable the students to

1. Understand the Systematic and External Anatomy of Cultivable Organisms
2. Discuss the basic structure offishes
3. Understand the classification of commercially important crustaceans and molluscs
4. Acquire knowledge on morphology shell fish

CORE COURSE –2 (A) – THEORY

AQC 102 :SYSTEMATICS AND EXTERNAL ANATOMY OF CULTIVABLE ORGANISMS

UNIT – I

1. FIN FISH SYSTEMATICS: Classification of fishes up to subclass level; major groups of fresh water fish and their salient features and distribution.

UNIT – II

2. FIN FISH ANATOMY : Basic structure of the skin in fishes; epidermal derivatives – microridges and integumentary glands; dermal derivatives – cosmoid scales, ganoid scales, placoid scales, elasmoid, cycloid and ctenoid scales; fish age and scales; integumentary pigments; mouth and jaws; gill slits; fins – median fins and paired fins, origin of paired fins; coloration – morphology of chromatophores, pigments, physical and chemical colours, mixed colours, colour change, adaptive significance.

UNIT – III

3.SHELL FISH SYSTEMATICS: Classification of commercially important crustaceans and molluscs up to sub class level and their salient features and distribution.

UNIT – IV

4.SHELL FISH ANATOMY: External morphology of shell fish: prawn, shrimp, crab and

molluscs – exoskeleton and appendages.

SUGGESTED READING :

1. Lagler, K. F., J. E. Bardach and R. R. Miller. 1977. Ichthyology. John Wiley.
2. Moyl, P. B. 1995. Fishes : An Introduction to Ichthyology. 3/Ed. Narendra Publishing House, New Delhi.
3. Talwar, P. K. and V. G. Jhingran. 1991. Inland Fishes of India and Adjacent Countries. Vol. I & II. Oxford and IBM Publishing Co., New Delhi.
4. Kurian, C. V. and V. O. Sebastian. 1976. Prawns and Prawn Fisheries of India. Hindustan Publishing Co., 1976.
5. Bond E. Carl. 1979. Biology of Fishes. Saunders.
6. Datta Munshi and Srivastava. 1995. Natural History of Fishes and Systematics of Fresh Water Fishes of India. Daya Publishing House, New Delhi.
7. Parihar, R. P. 1994. A Text Book of Fish Biology and Indian Fisheries. Central Publishing House, Allahabad.
8. Lankaster, E. R. 1996. A classification of animals from the point of view of Economic Zoology. Daya Publishing House, New Delhi.
9. Srivastava, C. B. L. 1999. Fish Biology. Narendra Publishing House, New Delhi.
10. Khann a, S. S. 1997. An Introduction to Fishes. Central Book Depot, Allahabad.

COURSE OUT COMES

CO1.Understand the Classification of Fishes and Distribution.
CO2.Understand the Finfish Anatomy.
CO3.Importance of Commercially important crustaceans and molluscs
CO4.Apply the concepts of Nature of External Morphology of shell fish
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	3	1	1	2	1	1	1	1	1	1	1
CO2	1	3	1	1	2	2	1	1	1	1	1	1
CO3	2	3	2	1	1	2	1	1	1	1	1	1
CO4	2	3	2	1	2	1	1	1	1	1	2	1

H-High-3, M- Medium-2, L- Low-1

AQC- 102: CORE COURSE –2 (B) – THEORY – ORNAMENTAL FISH CULTURE

COURSE OBJECTIVE
To enable the students to

1. Understand classification of ornamental fishes
2. Acquire knowledge on construction and setting up fresh water aquarium and it maintenance
3. Know diseases of aquarium fishes
4. Understand economic s of ornamental fish culture

AQC 102 : ORNAMENTAL FISH CULTURE

UNIT – I

1. Classification and characteristic features of common species of freshwater ornamental fishes.
2. Classification and characteristic features of common species of brackish water and marine ornamental fishes.

UNIT – II

3. Construction and setting up freshwater aquarium and its maintenance; aquarium plants.
4. Mass production of ornamental fishes – food and feeding habits, water quality maintenance, breeding and rearing.

UNIT – III

5. Bacterial and viral diseases of aquarium fishes – causes, symptoms and control.

6. Fungal, parasitic and nutritional deficiency diseases – causes, symptoms and control.

UNIT – IV

7. Setting up of an export oriented ornamental fish unit.
8. Economics of ornamental fish culture.

SUGGESTED READINGS :

1. V. K. Dey, 1986. **Ornamental Fishes**. MPEDA.
2. R. Santhanam. 1987. **A Manual of Freshwater Aquaculture**, Oxford X IBH.
3. V. Satyanarayana. 1996. **Fish culture**, Narendra Publishing House.
4. P. K. Talwar and A. G. Jhingran 1991. **Indian Fishes**, Oxford & IBH
5. Q. J. Shammi and S. Bhatnagar. 2002. **Applied Fisheries**, Agrobios (India)

COURSE OUT COMES

After completion of this course, students

CO1.Understand the Common species of fresh water ornamental fishes
CO2. Acquire knowledge on Mass production of ornamental fishes
CO3.Creating awareness on Diseases of aquarium fishes
CO4.Knowledge on Economics of ornamental fish culture
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	2	2	1	2	3	3	1	3	2	2	3
CO2	2	1	2	3	2	3	3	2	1	2	2	3
CO3	1	1	2	1	2	3	3	2	3	2	2	3
CO4	2	1	2	2	2	1	1	1	1	1	3	3

H-High-3, M- Medium-2, L- Low-1

AQC- 103: CORE COURSE –3 (A) – THEORY – FISH NUTIRITION AND WATER QUALITY MANAGEMENT

COURSE OBJECTIVE

To enable the students to:

1. Comprehensive knowledge on nutritional requirements in aquaculture
2. Know the principles and working application of supplementary feed
3. Understand the properties of fertilizers and liming
4. A quire knowledge on aeration in fish pond

AQC 103: FISH NUTIRITION AND WATER QUALITY MANAGEMENT

UNIT – I

1. NUTRITION: Importance of nutrition; nutritional requirements; nutritive needs of finfish with special reference to carps and cat fishes and shrimp and prawn; major nutrients – carbohydrates, proteins and lipids and their importance. Natural food and live feed culture: methods of collection of live feed organisms; identification, isolation and maintenance of phytoplankton and zooplankton; mass culture of spirulina and azolla, culture of rotifers (Brachionus and Moina) and artemia.
2. FOOD AND FEEDING HABITS : Types of food – basic food, secondary food, incidental food, obligatory food; feeding habits – detritivores, scavengers, herbivores, omnivores, carnivores, surface feeders, column feeders, bottom feeders; monophagic, stenophagic and euryphagic fishes; seasonal changes in food availability and food preferences; food and feeding in relation to age; food selectivity and feeding intensity; feeding strategies; food and feeding habits of prawns, shrimps, crabs and bivalves; morphological adaptations for feeding in fishes.

UNIT – II

3. SUPPLEMENTARY FEEDS : Supplementary feed and feed formulations; different types of feeds (dry feed, wet feed, floating feed, sinking feed and flakes); feed composition; nutrient source; feed ingredients (conventional and non-conventional, their nutritive value); water stability of feeds; use of attractants in feeds; binders; processing of feeds (importance of anabolic agents, antioxidants and mould inhibitors; anti nutritional factors); storage and quality control; determination of energy content in feeds.
4. FEEDING : Introduction; feeding and fish production; fate of nutrients in feed; water quality and feeding rates – temporal changes; relationship to maximum feeding rate; effects of weather on maximum feeding rate; effluents from fish ponds; off-flavor.

UNIT – III

5.FERTILIZATION: Properties of chemical fertilizers: Primary nutrients; secondary nutrients; sources of fertilizers; mixed fertilizers; solubility of fertilizers. Effects of fertilization on plants and invertebrates: Phytoplankton; zooplankton; benthos; macrophytes; water transparency as an index to fertilization; fish yield in fertilized ponds. Organic fertilizers: Sources; influence on pond ecology and fish production.

6.LIMING : Properties of liming materials – compounds, neutralizing value, fineness; effects of liming on pond ecosystem – chemistry, production of plankton and invertebrates; fish production; liming rates for ponds; application of liming materials for ponds – selection of liming material and time of application; methods of application; residual effects of liming.

UNIT – IV

7.DYNAMICS OF DISSOLVED OXYGEN : Introduction; diffusion; photosynthesis; respiration; diet changes in dissolved oxygen concentrations; predicting decline in dissolved oxygen concentrations; oxygen budgets of fish ponds; algal die-offs; overturns; identification of oxygen problems.

8.AERATION : Introduction; principles of aeration; emergency aeration; supplemental or continuous aeration; destratification; practical considerations.

9.MISCELLANEOUS TREATMENTS : Introduction; potassium permanganate; hydrogen peroxide; calcium hydroxide; reduction of pH; control of turbidity; salinity; hardness and chloride; water exchange; chlorine removal; rotenone; formalin and malachite green; methods of applying chemicals.

SUGGESTED READING :

1. Halver, J. E. 1972. Fish Nutrition. Academic Press, New York.
2. Sena, S. De Silva and Trever A. Anderson. Fish Nutrition in Aquaculture. Chapman & Hall London. 1998, p. 319.
3. Lovell, J. 1989. Nutrition and Feeding of Fish. Von Nostrand.
4. MPEDA, 1990. Hand Book on Aquafarming – Live feed.
5. MPEDA, 1990. Hand Book on Aquafarming – Aquaculture feed.
6. MPEDA 1990. Aquaculture Engineering and Water Quality Management. Cochin, India.
7. Pillay, T. V. R. Aquaculture: Principles and Practices. Fishing News Books.
8. Jhingran, V. G. 1985. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
9. Boyd, C. E. 1982. Water Quality Management for Pond Fish Culture.Elsevier Science Publishers.
10.Chakroff, M. 1993. Freshwater Fish Pond Culture and Management. Daya Publishing House, New Delhi.
11. Pillay, T. V. R. and W. A. Dill. 1979. Advances in Aquaculture. Fishing News Books Ltd.

COURSE OUT COMES

After the completion of the course, the students will be able to:

CO1.Aquire knowledge on the Importance of Nutrition
CO2.Understand the Food and Feeding Habits.
CO3.Importance of Supplementary feeds and Fertilization
CO4.Knowledge on Dynamics of Dissolved oxygen
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	3	1	1	2	1	1	1	1	3	2
CO2	2	2	3	1	1	3	1	1	1	1	3	3
CO3	1	1	3	1	1	2	1	1	1	1	3	1
CO4	3	1	3	1	3	3	1	1	1	1	1	2

H-High-3, M- Medium-2, L- Low-1

AQC103 Core Course- 3(B): -THEORY- ENVIRONMENTAL MONITORING AND BIODETERIORATION

COURSE OBJECTIVE

To enable the students to

1. Understand limitations for monitoring critical pollutants
2. Know the role of biotechnology in environmental pollution
3. Aquire knowledge on Control of bio deterioration of wood and synthetic substances in the sea
4. Understand prospects of sustainable development and current environment al problems in india and their management.

AQC 103 B: Environmental Monitoring and Biodeterioration

UNIT-I

1.Global environmental monitoring methods: Status and objectives, limitations for monitoring critical pollutants.

2.Role of biotechnology in environmental pollution control: Indicator organisms, Test organisms, Monitoring organisms, Enzymes.

UNIT-II

3.Coastal developmental activities-environmental issues.

4.Micro and Macro fouling, corrosion of metals and alloys in the sea, effects of bio-fouling and bio deterioration on marine structures.

UNIT-III

5.Protection methods against corrosion and fouling; Application of biotechnology in controlling the bio deterioration of wood and synthetic substances in the sea.

5.Red tides: Cause character and effects on the organisms of Marine environment.

UNIT-IV

6.Current Environmental Issues: Current environmental problems in India and their management. Urban waste and health: recycle of water and use; role of garden, park and reservoirs in environmental protection.

7.Sustainable development: an international perspective; Retrospect and prospects of sustainable environmental development

Text Books/References:

1. S.E. Nielsen: Tropical Pollution, 1982.
2. A.M.Chakravarthy: Biodegradation and detoxification of Environmental pollutants, CRC Press, 1928.
3. o.Kinne: Marine Ecology, Vol.V. Ocean Management 3&4 John Wiley & Sons. 1984.
4. Johnston R. (Ed.): Marine Pollution, Academic Press, 1976.
5. Patin S.A.: Pollution and Biological resources of the Oceans Butterworth & Co. Ltd., 1982.
6. Ruive M. (Ed.): Marine Pollution and Fishing News Sea Life 1972.
7. Venugopalan, V.K.: Pollution and Toxicology, CAS in Marine Biology, 1991.
8. Rita Colwell (Ed): Biotechnology in Marine Sciences, Academic Press, 1981.
9. Prakash P.: Textbook of Marine Pollution.
10. Gupta, P.K.: Introduction to Biotechnology.

COURSE OUT COMES

After completion of this course, students

CO1Understand the Global Environmental monitoring methods
CO2 Aquire knowledge on Coastal development activities
CO3 Creating awareness on Protection methods against corrosion and fouling
CO4 Knowledge on Current Environmental issues
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	1	2	1	1	2	1	1	1	1	1	1
CO2	1	1	1	1	1	1	1	1	1	1	1	1
CO3	2	1	1	2	2	1	1	1	1	2	1	1
CO4	3	1	1	3	1	1	2	1	1	1	1	2

H-High-3, M- Medium-2, L- Low-1

PRACTICAL -I

AQC104: IDENTIFICATION AND MORPHOLOGY OF CULTIVABLE ORGANISMS MARKS : 50

1. Identification of commercially important finfish – marine fishes, freshwater fishes, exotic carps, ornamental fishes, predatory fishes and weed fishes.
2. Identification of commercially important shellfish – crabs, prawns and shrimps.
3. Identification of eggs and larval forms of cultivable finfish and shellfish.
4. Identification of fins and scales of fish; mounting of scales.
5. Collection and identification of fish food organisms.
6. Biometric analysis.
7. Length-weight relationship.
8. Dissections: (1) Digestive system (2) Reproductive system in finfish and shellfish.
9. Identification of different crafts and gear.
10. Identification of aquatic insects.
    Identification of aquatic weeds.

AQC- 105: Skill Oriented Course 1 (A) – THEORY- COASTAL AQUACULTURE

Course Objectives

To enable the students to:

COURSE OBJECTIVE

1. Understand seed collections from natural resources
2. Aquire knowledge on Crab culture and Lobster culture
3. Understand the methods of Double cropping
4. Comprehension knowledge on Oysters, pearl oysters and mussels

AQC- 105: COASTAL AQUACULTURE

UNIT – I

1.SHRIMP HATCHERY MANAGEMENT: Seed collection from natural resources, identification of post larval stages, brood stock management, breeding by eyestalk ablation, hatchery management, larval rearing of *Penaeus monodon*. Shrimp Culture Management: Culture of *P.vannamei* and *P.mondon*

2.CRAB CULTURE: Culture of *Scylla serrata, Scylla oceanica, Scylla tranquibarica*.

3.LOBSTER FISHERY: Distribution – biology of spiny lobster – abundance of spiny lobster - culture of spiny lobster – processing and preservation of lobsters.

UNIT – II

4.CRAY FISH CULTURE: Culture of *Procambarusclarkii*– pond culture methods – double cropping.

5.MOLLUSCAN CULTURE: Oysters, pearl oysters and mussels.

UNIT – III

6.SEAWEED CULTURE: Seaweed morphology, biology, reproduction, importance of seaweeds; culture of seaweeds.

7.MARINE AND BRACKISHWATER FISH CULTURE: Culture of*Lates calcarifer, Etroplussuratensis*and *Mugil cephalus*.

UNIT – IV

8. POST HARVEST TECHNOLOGY: Harvesting methods - drainable ponds, undrainable ponds,cage and raceway farms, handling and transport; principles and importance of fish preservation; preservation methods - traditional and advanced methods of fish preservation – sun drying, salt curing, pickling, smoking, chilling, freezing and canning.

9. PRESERVATION AND PROCESSING : Processing and preservation of fish products and byproducts – minced meat, FPC, fish meal, fish oils, fish hydrolsate, fish sauce, fish glue; sanitation in processing plants and quality control of fresh and processed fish and fishery products; IQF shrimp Freezing.

SUGGESTED READING :

1. MPEDA, **Hand Book on Aquafarming,** Shrimps, lobsters, mudcrabs (1996).
2. Nandi, N. C. and S. K. Pramanik. 1994. **Crabs and crab Fisheries of Sundarban**. Hindustan Publishing Corporation.
3. Pillay, T. V. R. 1988. **Aquaculture, Principles and Practices**. Fishing News Books.
4. Piska, R. S. 1999. **Fisheries and Aquaculture.** Lahari Publications, Hyderabad.
5. Pandian, T. J. 2001. **Sustainable Indian Fisheries.** National Academy of Agricultural Sciences.
6. Sahoo, D. and S. Z. Qasim. 2002. **Sustainable Aquaculture.** APH Publishing Corporation, New Delhi – 110 002.
7. MPEDA – Hand Book on Aqua farming – **Fish Processing, Quality Control & Marketing**. 1995. Kochi, India.
8. Pillay, T. V. R. 1993. **Aquaculture: Principles and Practices**. Fishing News Books.

COURSE OUT COMES

1. Understand the Shrimp hatchery management
2. A quire knowledge on Crab culture, cray fish culture and Molluscan culture
3. Creating awareness on Seaweed culture
4. Knowledge on Post harvest technology

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	1	1	1	1	2	2	2	3	2	2
CO2	2	3	2	1	2	2	2	1	2	2	1	1
CO3	2	1	1	1	3	1	1	1	1	1	2	1
CO4	2	3	1	1	3	2	1	1	1	1	1	1

H-High-3, M- Medium-2, L- Low-1

AQC 105: Skill Oriented Course 1 – (B) - CAPTURE FISHERIES

COURSE OBJECTIVE

1. Understand crafts, gears, nets from natural resources
2. Acquire knowledge on commercial reservoirs
3. Understand the methods of fisheries in India.
4. Comprehension knowledge on clupepods, prawns and mullets.

AQC 105: CAPTURE FISHERIES

UNIT – I

1. **CRAFTS-** Introduction to fishing crafts; types of fishing crafts: indigenous crafts – coracle, sangadam, shoe dhonl, catamaran, tuticorin boats, dugout canoe, outrigger canoes, masula boats; / built up boats – Kakinada nava, Machilipatnam nava, dinghy and nauka. Materials used for construction of fishing crafts-timber,metalsforsheating,metallicfitting, protection of the boat.

1. **GEAR** – types of fishing gear – disabling type, traps and barriers, filtering type, entangling type, self-fishing type, wounding gear.

   NETS – types of nets; common fishing gears for inland waters – traps, angling, cast net, stake net, hand seings, gill net. Gears for spawn collection – Midnapore type of net, murshidabad type of net, lalgola type, jaunpur type. Gamcha, - midnapore type, murshidabad type – materials used for fishing gear; preservation of fishing gears.

UNIT – II

2. **RIVERINE FISHERIES OF INDIA :**Ecology of riverine environment; different river systems and their fisheries; regulations of populations and exploitation; improvement of fish stocks; status of spawn prospecting; fisheries of major and minor carps and cat fishes.
3. **LACUSTRINE FISHERIES:** Lakes and reservoirs; development of reservoir fisheries; commercial exploitation of reservoirs; recent advances in reservoir management.

UNIT – III

4. **MARINE FISHERIES:** Marine fishery resources of India; historical background and recent trends; problems of inshore fisheries; fishery resources of the continental shelf; exploitation and management of under exploited and unexploited resources of EEZ.
5. **PELAGIC FISHERIES:** Pelagic fishery resources of India; fisheries of oil sardine, lesser sardines, anchovies, mackerel, ribbon fishes and cephalopods.
6. **DEMERSAL FISHERIES:** Fisheries of elasmobranchs; Bombay duck, silver bellies, threadfins and other perches; flat fishes, shrimps, crabs, oysters and clams.

UNIT – IV

8. **ESTUARINE FISHERIES:** Definition; origin and classification;

types of estuaries in India and their fishery resources fisheries o brackish water lakes and backwaters; problems confronting brackish water capture fishers.

1. fisheries of clupepoids,prawns and mullets;fisheries of brackish water lakes and backwaters;problems confronting brackishwater capture fisheries.

SUGGESTED READING:

1. Jhingran, V. G. 1985. **Fish and Fisheries of India**. Hindustan Publishing Corporation, New Delhi.
2. Kurian, C. V. and O. V. Sebastian, 1982. **Prawns and Prawn Fisheries of India**. Hindustan Publishing Corporation, New Delhi.
3. Srivastava, U. K. and Dharma Reddy. 1983. **Cold Water Fisheries of India**. Concept Publishing Co., New Delhi.
4. Bal, D. V. and K. V. Rao. 1990. **Marine Fisheries**. Narendra Publishing House, New Delhi.
5. **Proceedings of the Symposium of Living Resources of the Seas around India**. CMFRI. 1973. Spl. Publ. CMFRI. Cochin.
6. FAO, **Year Book of Fishery Statistics** (Yearly).
7. Talwar, P. K. and R. K. Kacker. 1984. **Commercial Sea Fishes of India**. ZSI, Kolkata.
8. Khanna, S. S. 1997. **An Introduction to Fishes**. Central Book Depot, Allahabad.
9. Sinha, V. R. P. 1993.**A Compendium of Aquaculture Technologies**. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
10. Piska, R. S. 1999. **Fisheries and Aquaculture.** Lahari Publications, Hyderabad.
11. Pandian, T. J. 2001. **Sustainable Indian Fisheries.** National Academy of Agricultural Sciences.

COURSE OUT COMES

After completion of this course, students will be able to:

CO1 Understand the types of fishing crafts, gears and nets.

CO2 Acquire knowledge on Aquaculture fisheries

CO3 Creating awareness on marine, pelagic and demersal fisheries.

CO4 Knowledge on estuarine fisheries and Management

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	2	1	2	2	3	2	1	1	2	2
CO2	3	3	3	1	3	2	1	1	1	2	2	1
CO3	3	2	2	1	2	2	1	1	1	3	2	2
CO4	2	2	2	1	3	1	2	1	1	1	1	2

H-High-3, M- Medium-2, L- Low-1

AQC 106 Skill Oriented Course 2 (A) : GENERAL PRINCIPLES AND PRACTICES OF AQUACULTURE

COURSE OBJECTIVE

To enable the students to

1. Understand types of culture systems in aquaculture
2. Acquire knowledge on aquatic weeds
3. Understand induced breeding and seed fish production
4. Determined culture of Indian major carps

AQC 106 : GENERAL PRINCIPLES AND PRACTICES OF AQUACULTURE

UNIT – I

1.Definition of Aquaculture: Types of culture, pond preparation and selection of species for culture.

2. Control of aquatic weeds and predators; management of fish ponds.

UNIT – II

3. Induced breeding and seed fish production in carps; transport of seed fish and breeders.
4. Food and feeding in fish - live feed and artificial feeds.
5.Measurement of growth : Length - weight relationship; determination of age in fishes; growth hormones

UNIT – III

6. Culture of Indian major carps and air breathing fishes.
7. Culture of shrimp and prawn.
8. Integrated fish farming; aquarium fish and their maintenance.

UNIT – IV

9. Bacterial and viral diseases of fish - causes, symptoms diagnosis and control measures.
10. Protozoan and fungal diseases and their control.

SUGGESTED READINGS :

1. Santhanam, R. et.al. 1990. **A Manual of Fresh Water Aquaculture** Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

2. Khanna, S. S. 1997. **An Introduction to Fishes**. Central Book Depot, Allahabad.

3. Pillay, T. V. R. 1993. **Aquaculture : Principles and Practices**. Fishing News Books

4. Jhingran, V. G. 1982. **Fish and Fisheries of India**. Hindustan Publishing Corporation, New Delhi

5. MPEDA 1990. **Aquaculture Engineering and Water Quality Management**. Cochin, India.

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

7. Conroy, D. A. and Herman, R. L. 1968. **Text Book of Fish Diseases**. T.F.H. (Gt. Britain) Ltd.

COURSE OUT COMES

CO1. Understand the Definition of Aquaculture
CO2. Acquire knowledge on Induced breeding and seed fish production in carps
CO3.Creating awareness on Culture of Indian major carps
CO.4 Knowledge on Bacterial , viral , Protozoan and Fungal diseases
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	3	2	2	3	1	1	1	1	1	1	2
CO2	3	2	2	2	3	3	1	1	2	2	3	3
CO3	3	3	3	1	3	3	1	1	1	1	1	1
CO4	3	1	1	3	3	2	3	3	3	3	2	2

H-High-3, M- Medium-2, L- Low-1

AQC 106 Skill Oriented Course 2 (B) :AQUATIC FOOD SAFETY &QUALITY MANAGEMENT

CO1: To introduce the basic concepts about Uniqueness of Seafood quality control and its management.

CO2: To discuss about fish spoilage and quality assessment; enzymic and non enzymatic deteriorations.

CO3: To study about Recognized Specific spoilage organisms and Mechanism of Microbial Spoilage.

CO4: To understand the Methods of Quality Assessment of Fish and Fishery Products and changes during spoilage.

CO5: To study about Traditional Quality Control and Food Safety with Special Reference to HACCP System.

UNIT-I: Quality control

1) Quality Control; Uniqueness of Seafood quality control; Quality management/assurance.

2) Intrinsic quality, Species, Size, Sex, Condition and composition; Parasities and other organisms; Naturally toxic fish; Contamination with pollutants; Occasional Peculiarities

3) Extrinsic quality; Quality Deterioration and Extrinsic Quality defects in fish (Raw material).

Learning Outcome:

Upon completion of the above unit they are able to understand the concept of Uniqueness of Seafood quality control and its management.

UNIT-II: Microbial Spoilage

1) Fish spoilage and Quality Assessment
2) Enzymic Action, Non- enzymatic Deteriorations
3) Microbial Spoilage
Learning Outcome: Students will get awareness about fish spoilage and quality assessment and enzymic and non enzymatic deteriorations.

UNIT-III: Quality Problems in Seafood Industry

1)Poor Quality Raw Materials;
2) Recognised Specific spoilage organisms (SSOs);
3) Mechanism of Microbial Spoilage; Spoilages and Quality Indices in Frozen Fish; Freezing Process; Frozen Strorage.
Learning Outcome: Upon completion of the above unit they are able to understand the recognized specific spoilage organisms and mechanism of microbial spoilage.
UNIT-IV: Quality Assessment of Fish and Fishery Products
1)Methods of Quality Assessment; Organoleptic/Sensory-Subjective and Objective; a. appearance; b. Flavour; c. Taste; d. Odour; e. Texture; Interaction of Taste, Odour, Texture and Flavour; Sensory Testing Methods.
2) Selection of Test Subjects; i) Discrimination Tests ii) Preference Tests; iii) Training of Panel Members; iv) Presentation of samples.
3) Changes during Spoilage; i) Condition of the Skin (Sight and Touch); ii) Appearance of the Eye (Sight); iii) Condition of the Gills (Sight and Smell); iv) Condition of the Flesh (Touch and Sight).

Learning Outcome: Students will get awareness about Methods of quality assessment and changes during spoilage.

UNIT-V: Concept of Quality Management

i)Traditional Quality Control; Modern Safety and Quality Assurance Methods and Systems; Methods to Manage Quality and Safety; i) Good Hygienic Practices/ Good Manufacturing Practices; ii) Hazard Analysis Critical Control Point; iii) Quality Control (QC); iv) Quality Management; v) Quality Systems; vi) Total Quality Management (TQM); vii) Good Manufacturing Practices in Fish Handling

2) Food Safety with Special Reference to HACCP System; i) The HACCP Concept; ii) Advantages of HACCP; iii) Applications of HACCP

3)Determine Critical Control Points.

Learning Outcome: On completion of the above unit they are able to understand the traditional quality control and food safety with special reference to Hazard Analysis Critical Control Point and its applications.

REFERENCE BOOKS:

1) Bond, et al.1971.Fish Inspection and Quality Control. Fishing News Books, England.
2) Huss HH,JakobsenM&ListonJ.1991.Quality AssuranceintheFishIndustry.Elsevier.
3) JohnDEV. 1985. FoodSafety and Toxicity.CRCPress.
4) KrenzerR.1971.FishInspectionandQualityControl.FishingNews.
5) RegensseinJM&RegensseinCE.1991.Introduction to Fish Technology. Van No strand Reinhold.
6) Govindan,TK. 1985.Fish Processing Technology, Oxford-IBH.

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	1	2	1	2	1	2	2	1	2	1	1
CO2	2	2	1	1	2	1	2	1	2	2	1	1
CO3	2	1	2	2	1	2	1	2	2	1	1	1
CO4	1	2	1	2	1	2	1	1	2	1	1	1
CO5	2	1	3	1	2	1	2	1	2	2	1	1

PRACTICAL -II - AQC 107: FISH NUTRITION Marks: 50

1. Estimation of total proteins, carbohydrates and lipids in fish feeds.
2. Estimation of ash content.
3. Estimation of inorganic ions through flame photometer.
4. Estimation of fiber content in fish feeds.
5. Determination of amino acid profiles through paper chromatography.
6. Effect of different feeds on digestibility, FCR and FCE.
7. Determination of energy contents using bomb colorimeter.
8. Proximate composition of fish digestive tract.

AQC : 108 OPEN ONLINE TRANSDISCIPLINARY COURSE - I

AUDIT COURSE : AQC : 109 INDIAN KNOWLEDGE SYSTEMS - I

II SEMESTER

CORE COURSE -4 – THEORY AQC 201: PRINCIPLES OF AQUACULTURE

COURSE OBJECTIVE

To enable the students to

1. Describe the Principles of Aquaculture
2. Identify the Design Construction of pond
3. Indicate the Biological characterstics of aquaculture species
4. Acquire knowledge on measurement of growth and water and soil quality parameter.

Semester – II

AQC 201 : PRINCIPLES OF AQUACULTURE

UNIT – I

1. **AQUACULTURE SYSTEMS AND METHODS:** Scope and definition; origins and growth of aquaculture; biological and technological basis; Traditional, extensive, semi - intensive and intensive culture; monoculture, polyculture, composite culture, mixed culture, monosex culture; cage culture, pen culture, raft culture, race way culture, culture in circulatory systems; warm water and cold water aquaculture; sewage – fed fish culture, integrated fish farming.

2. **SELECTION OF SITES:** Survey and location of suitable site – topography; soil characteristics;acid sulphate soils; water source; hydrometerological data.

UNIT – II

3. **AQUACULTURE ENGINEERING :**Design and construction of pond, layout and design of aquaculture farm, construction, water intake system, drainage system; aeration and aerators; recent advances in aquaculture engineering; tips for better aquaculture practices; design and construction of hatcheries.
4. **HYDROLOGY OF PONDS :**Types of ponds; sources of water – precipitation, direct run off, stream inflow, ground water inflow, regulated inflow; losses of water– evaporation, seepage, outflow, consumptive use, water budgets of embankment ponds; water budget of an excavated pond; water exchange.

UNIT – III

5. **SELECTION OF SPECIES:** Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation.
6. **PRE STOCKING MANAGEMENT:** Sun drying, ploughing / tilling, desilting, liming and fertilization, eradication of weed fishes.
7. **STOCKING:** Acclimatization of seed and release; species combinations; stocking density; ratio.

UNIT – IV

8. **POST STOCKING MANAGEMENT :** Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms; specific food consumption, food conversion ratio (FCR), protein efficiency ratio, true net protein utilization, apparent net protein utilization, biological value of protein.

9. GROWTH : Measurement of growth; length - weight relationship; methods of determination of age in fishes and shellfish based on length data and growth checks; ponderal index; growth hormones.

SUGGESTED READING :

1. Mathew Landau. 1995. **Introduction to Aquaculture**. Daya Publishing House, New Delhi.
2. Pillay, T. V. R. 1993. **Aquaculture: Principles and Practices**. Fishing News Books. Black Well Scientific Publications.
3. MPEDA, 1991. **Hand Book on Shrimp Farming**, Kochi, India.
4. Jhingran, V. G. 1982. **Fish and Fisheries of India**. Hindustan Publishing Corporation, New Delhi.
5. Chakrabarti, N. M. 1998. **Biology, Culture and Production of Indian Major Carps**. Narendra Publishing House, New Delhi.
6. Coche, A. G. and J. F. Muir. 1996. **Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts– Simple Methods for Aquaculture**. FAO. Daya Publishing House, New Delhi.
7. Upadhyay, A. S. 1995. **A Hand Book on Design, Construction and Equipments in Coastal Aquaculture (Shrimp Farming)**. Daya Publishing House, New Delhi.
8. Wheaton, F. W. 1985. **Aquaculture Engineering**. MPEDA, Cochin.
9. MPEDA 1990. **Aquaculture Engineering and Water Quality Management**. Cochin, India.

COURSE OUT COMES

After completion of this course, students will be able to:

CO1.Understand the Aquaculture systems and methods
CO2.Aquire knowledge on Aquaculture Engineering
CO3.Creating awareness on selection of species and Hydrology of ponds
CO4.Knowledge on Pre stocking Management and Post stocking management and growth.

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	2	2	2	1	3	2	1	1	1	2	2	2
CO2	2	2	2	1	2	1	2	1	1	1	2	2
CO3	2	2	2	1	2	2	2	1	2	1	2	2
CO4	3	3	3	1	3	2	2	2	2	2	2	2

H-High-3, M- Medium-2, L- Low-1

COURE COURSE – 5(A) – THEORY

AQC 202: PHYSIOLOGY OF CULTIVABLE ORGANISMS

COURSE OBJECTIVE

To enable the students to

1. Recognize the Physiology of cultivable Organisms.
2. Understand the digestion and respiration.
3. Creating awareness on neuroendocrine system and reproduction.
4. Knowledge on Bioluminescence, mating and parental care.

(A) - COURE COURSE – 5(A) - AQC 202 : PHYSIOLOGY OF CULTIVABLE ORGANISMS

UNIT – I

2. **DIGESTION:** Digestive systems, digestive enzymes, absorption and assimilation.
3. **RESPIRATION :**Respiratory organs, mechanisms of ventilation, respiratory pigments, gaseous exchange mechanism, response of the respiratory system to external changes; accessory respiratory organs.

UNIT – II

4. **EXCRETION AND OSMOREGULATION:** Mechanism of excretion – kidney structure and functions of freshwater and marine teleosts. Osmoregulation in freshwater fishes and marine fishes and salt balance.
5. **CIRCULATORY SYSTEM:** Arteries and veins; mechanical properties and regulation of cardiac activity; general properties of the cardiovascular system; effects of drugs.

UNIT – III

6. **NEUROENDOCRINE SYSTEM:** Neuroendocrine system in finfish; neuroendocrine regulation of moulting and reproduction in crustaceans.
7. **REPRODUCTION:** Reproductive cycles, sexual maturity, spawning and fecundity, gonado somatic index, fertilization, hormones and reproductive behaviour in fishes.

UNIT – IV

8. **BIOLUMINISCENCE:** Light organs – biochemistry, regulation of light emission, significance and employment of luminescence.
9. **MATING AND PARENTAL CARE :**The abyssal and pelagic eggs; attachment devices; spawning sites; nest building and other means of parental care; ovoviviparity and viviparity; types of larvae; metamorphosis; larval life and feeding habits of larvae in finfish and shellfish.

SUGGESTED READING :

1. Hoar W.S. and D. J. Randal. 1976. **Fish Physiology**. Vol. I to IX Academic Press, New York.
2. Khanna, S. S. 1996. **An Introduction to fishes.** Central book depot, Allahabad.
3. Lynwood S. Smith. 1999. **Introduction to Fish Physiology.** Narendra Publishing House, Delhi.
4. Harper, A. L. 1989. **Physiological Chemistry**.
5. Lagler, K. F., J. E. Bardach and R. R. Miller.1972. **Ichthyology**. John Wiley.

COURSE OUT COMES

After completion of this course, students will be able to:

CO1 To Understand the metabolism of fishes and prawns
CO2 Acquire knowledge on Neuroendocrine system
CO3 Creating awareness on bioluminescence
CO4 Knowledge on fertilization and parental care

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	2	2	3	1	2	3	3	2	2	2	2	2
CO2	2	2	2	1	2	3	2	1	3	2	2	1
CO3	3	2	3	1	2	3	2	2	3	2	2	2
CO4	2	2	2	1	2	3	2	3	3	3	3	3

H-High-3, M- Medium-2, L- Low-1

(B)- CORE COURSE -5(B) – THEORY

AQC 202 - AQUACULTURE ENGINEERING

COURSE OBJECTIVE

To enable the students to

1. To learn the basic aspects of successful farm designing for effective management and optimum yield

2. Students will learn about design and construction of Freshwater fish farm and brackish water shrimp farm
3. Students will get an understanding of design and construction of Fish hatchery and Shrimp hatchery
4. Students will get an understanding of design and construction of culture systems like Cages and Rafts, Pens and Enclosures, and Raceway Farms

UNIT – I

5. **Planning and Aquaculture Development:** Priorities, resources, technology, human resources, legal and environmental factors and organization of aquaculture.
6. **Selection of Sites for Aquaculture:** Criteria for site selection of fresh water and brackish water farms - land based and open water farms; quantity and quality of water, sources of pollution and conflicts.
7. **Farm/hatchery standards and bio-securitymeasures**: Sanitary and Phyto-Sanitary (SPS) measures; Better Management Practices (BMP's)

UNIT – II

8. **Freshwater Fish Farm** -Design and construction: Layout of farm, size of the farm, division of the farm area; size, shape and depth of ponds; dike design, pond bottom and harvesting sump; water supply and drainage system of pond – pipes, sluice, monk, turn-down pipe; aerators and method of construction.
9. **Brackish water Shrimp Farm** -Design and construction: Layout designs, design of water management systems, design of water control structures, design of peripheral and internal dikes, water supply and drainage, method of construction.

UNIT – III

10. **Fish Hatchery -** Design, construction: Criteria for site selection of hatchery and nursery; Design and construction of Jar hatchery and Chinese hatchery system.
11. **Shrimp Hatchery** - Design and construction:Site selection and facilities required – maturation tanks, spawning tanks, larval rearing tanks, live food culture tanks, water storage and filtration tank, aeration, seawater supply and piping system; Lay-out and construction.

UNIT – IV

12. **Cages and Rafts:** Design and construction.
13. **Pens and Enclosures:** Design and construction
14. **Raceway Farms:** Design and construction.

REFERENCE BOOKS

1. Bose AN. *et al*., 1991. *Coastal Aquaculture Engineering*. Oxford & IBH Publishing Co. Pvt. Ltd.
2. Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House
3. CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries*. CIFE, Versova, Mumbai
4. FAO. 2007. *Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery*
5. Hepher B&Pruginin Y. 1981. *Commercial Fish Farming.* John-Willey & Sons Inc.
6. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
7. Ivar LO. 2007. *Aquaculture Engineering*. Daya Publ. House.
8. Jhingran VG & Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.
9. Misra R and Dora KC. 2015. A text Book on Aquaculture Engineering, Narendra Publishing House, New Delhi.
10. MPEDA. 1993. *Handbook on Aqua Farming - Live Feed. Micro Algal Culture.* MPEDA Publication
11. Pilley, TVR & Dill, WMA. 1979. *Advances in Aquaculture*. Fishing News Books, Ltd. England.
12. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell.
13. Stickney RR. 1979. *Principles of Warm waterAquaculture*. John-Willey & sons Inc.
14. Thomas L. 1995. *Fundamentals of Aquacultural Engineering*. Chapman & Hall
15. Thomas PC, Rath SC & Mohapatra KD.2003.*Breeding and Seed Production of Finfish and Shellfish.* Daya

Publ.
16. Wheaton FW. 1977. *Aquacultural Engineering*. John Wiley & Sons.

COURSE OUT COMES

After completion of this course, students

CO1 Methods of planning for aquaculture development

CO2 Criteria to be followed for selection of aquaculture sites and

CO3 Important aspects of farm/hatchery standards and bio-security measures.

CO4 Knowledge on Design and construction

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	3	3	2	3	2	1	1	1	3	3	3
CO2	3	2	2	2	3	2	3	2	1	3	1	2
CO3	3	2	1	3	2	3	2	2	1	3	3	3
CO4	3	3	3	3	3	3	2	1	1	1	3	3

H-High-3, M- Medium-2, L- Low-1

COURE COURSE 6 (A)– AQC: 203 - FRESHWATER AQUACULTURE

COURSE OBJECTIVE

To enable the students to

1. Understand the culture of Indian Major carps
2. Acquire knowledge on hatchery management
3. Creating awareness on Fresh water pearl culture
4. Knowledge on important Aquarium fishes and management

AQC 203 :FRESHWATER AQUACULTURE

UNIT – I

1. **CULTURE OF INDIAN MAJOR CARPS** – Catla, Rohu, Mrigal
2. **CULTURE OF EXOTIC CARPS** – Grass carp, common carp, silver carp, tilapia
3. **CULTURE OF AIR BREATHING FISHES** – Murrels and cat fishes

UNIT – II

HATCHERY MANAGEMENT:

4. **FISH:** Induced breeding; hypophysation of Indian Major carps; types of hatcheries - Hapa, Jar hatchery, circular hatchery (Chinese hatchery), Modern Indian hatchery system.
5. **FRESHWATER PRAWN:** Identification of post larval stages; brood stock management, breeding and Hatchery management, larval rearing.

UNIT – III

6. **FRESHWATER PRAWN CULTURE:** Seed collection from natural sources; culture of M.*rosenbergii/ M.malcolmsonii*
7. **FRESHWATER PEARL CULTURE:** Definition and scope, origin of pearls, pearl producing molluscs; freshwater pearl culture in the World and in India; types of pearls; mantle cavity insertion, mantle tissue insertion, gonadal insertion; water quality management.

UNIT – IV

7. **AQUARIUM FISHES AND MANAGEMENT :** Identification of commercially important ornamental fishes, setting and design of freshwater aquarium; taxonomy of species; live bearing fishes; egg laying fishes; biology of ornamental fishes; physiochemical properties of water used in aquaria; aquatic plants and other structures for beauty and utility; common aquarium fish diseases and their control; preparation of supplementary feeds and mass production of ornamental fishes.

SUGGESTED READING:

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. Pandian, T. J. 2001. **Sustainable Indian Fisheries.** National Academy of Agricultural Sciences.

COURSE OUT COMES

After completion of this course, students will be able to:

CO1 Understand the Culture of Indian Major carps

CO2 Acquire knowledge on Aquaculture Hatchery Management

CO3 Creating awareness on Fresh water prawn culture

CO4 Knowledge on Aquarium fishes and Management

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	2	3	3	1	2	3	2	2	2	2	2	2
CO2	3	3	3	1	3	3	3	2	2	2	3	2
CO3	3	3	3	1	3	2	2	2	1	1	1	2
CO4	3	2	3	1	3	3	2	2	1	2	2	2

H-High-3, M- Medium-2, L- Low-1

CORE COURSE -6(B) – THEORY

AQC 203: CAPTURE FISHERIES

COURSE OBJECTIVE

5. Understand crafts, gears, nets from natural resources
6. Acquire knowledge on commercial reservoirs
7. Understand the methods of fisheries in India.
8. Comprehension knowledge on clupepods, prawns and mullets.

AQC 203: CAPTURE FISHERIES

UNIT – I

2. **CRAFTS-** Introduction to fishing crafts; types of fishing crafts: indigenous crafts – coracle, sangadam, shoe dhonl, catamaran, tuticorin boats, dugout canoe, outrigger canoes, masula boats; / built up boats – Kakinada nava, Machilipatnam nava, dinghy and nauka. Materials used for construction of fishing crafts-timber,metalsforsheating,metallicfitting, protection of the boat.

8. **GEAR** – types of fishing gear – disabling type, traps and barriers, filtering type, entangling type, self-fishing type, wounding gear.
NETS – types of nets; common fishing gears for inland waters – traps, angling, cast net, stake net, hand seings, gill net. Gears for spawn collection – Midnapore type of net, murshidabad type of net, lalgola type, jaunpur type. Gamcha, - midnapore type, murshidabad type – materials used for fishing gear; preservation of fishing gears.

UNIT – II

9. **RIVERINE FISHERIES OF INDIA :**Ecology of riverine environment; different river systems and their fisheries; regulations of populations and exploitation; improvement of fish stocks; status of spawn prospecting; fisheries of major and minor carps and cat fishes.
10. **LACUSTRINE FISHERIES:** Lakes and reservoirs; development of reservoir fisheries; commercial exploitation of reservoirs; recent advances in reservoir management.

UNIT – III

11. **MARINE FISHERIES:** Marine fishery resources of India; historical background and recent trends; problems of inshore fisheries; fishery resources of the continental shelf; exploitation and management of under exploited and unexploited resources of EEZ.
12. **PELAGIC FISHERIES:** Pelagic fishery resources of India; fisheries of oil sardine, lesser sardines, anchovies, mackerel, ribbon fishes and cephalopods.
13. **DEMERSAL FISHERIES:** Fisheries of elasmobranchs; Bombay duck, silver bellies, threadfins and other perches; flat fishes, shrimps, crabs, oysters and clams.

UNIT – IV

8. **ESTUARINE FISHERIES:** Definition; origin and classification;
types of estuaries in India and their fishery resources fisheries o brackish water lakes and backwaters; problems confronting brackish water capture fishers.

10. fisheries of clupepoids,prawns and mullets;fisheries of brackish water lakes and

backwaters;problems confronting brackishwater capture fisheries.

SUGGESTED READING:

12. Jhingran, V. G. 1985. **Fish and Fisheries of India**. Hindustan Publishing Corporation, New Delhi.
13. Kurian, C. V. and O. V. Sebastian, 1982. **Prawns and Prawn Fisheries of India**. Hindustan Publishing Corporation, New Delhi.
14. Srivastava, U. K. and Dharma Reddy. 1983. **Cold Water Fisheries of India**. Concept Publishing Co., New Delhi.
15. Bal, D. V. and K. V. Rao. 1990. **Marine Fisheries**. Narendra Publishing House, New Delhi.
16. **Proceedings of the Symposium of Living Resources of the Seas around India**. CMFRI. 1973. Spl. Publ. CMFRI. Cochin.
17. FAO, **Year Book of Fishery Statistics** (Yearly).
18. Talwar, P. K. and R. K. Kacker. 1984. **Commercial Sea Fishes of India**. ZSI, Kolkata.
19. Khanna, S. S. 1997. **An Introduction to Fishes**. Central Book Depot, Allahabad.
20. Sinha, V. R. P. 1993.**A Compendium of Aquaculture Technologies**. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
21. Piska, R. S. 1999. **Fisheries and Aquaculture.** Lahari Publications, Hyderabad.
22. Pandian, T. J. 2001. **Sustainable Indian Fisheries.** National Academy of Agricultural Sciences.

COURSE OUT COMES

After completion of this course, students will be able to:
CO1 Understand the types of fishing crafts, gears and nets.
CO2 Acquire knowledge on Aquaculture fisheries
CO3 Creating awareness on marine, pelagic and demersal fisheries.
CO4 Knowledge on estuarine fisheries and Management
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	2	1	2	2	3	2	1	1	2	2
CO2	3	3	3	1	3	2	1	1	1	2	2	1
CO3	3	2	2	1	2	2	1	1	1	3	2	2
CO4	2	2	2	1	3	1	2	1	1	1	1	2

H-High-3, M- Medium-2, L- Low-1

PRACTICALS

AQC 204 PRACTICAL III : SOIL AND WATER CHARACTERISTICS

1. Determination of temperature, pH and transparency.
2. Estimation of dissolved oxygen and primary productivity.
3. Estimation of carbon dioxide.
4. Estimation of total ammonia – nitrogen and nitrate – nitrogen.
5. Estimation of phosphates.
6. Estimation of iron.
7. Estimation of chlorine
8. Determination of hardness.
9. Estimation of organic matter and biological oxygen demand (BOD)
10. Determination of salinity.
11. Plankton analysis.

SKILL ORIENTED COURSE - 3 – AQC 205: FISHERY ECONOMICS, EXTENSION AND ENVIRONMENTAL MANAGEMENT

COURSE OBJECTIVE

To enable the students to

1. Understand the concepts of Fishery Economics

2. Describe the role and responsibilities of marketing
3. Knowledge on Finance of Aquaculture
4. Knowledge on utility on remote sensing techniques for the identification of suitable grounds for aquaculture

(A)- SKILL ORIENTED COURSE - 3 – AQC 205 : FISHERY ECONOMICS, EXTENSION AND ENVIRONMENTAL MANAGEMENT

UNIT – I

1. **AQUACULTURE ECONOMICS :**Production economics – definition of economics and application of economic principles to aquaculture; the input-output relationship; maximum level of input; least-cost combination of inputs; maximum level of output; combination of products; economics of size; partial budget analysis.

2. **MARKET ECONOMICS:** Basic concepts in demand and price analysis; supply and demand for fish; elasticity of demand (price elasticity of demand, income elasticity of demand, cross elasticity of demand).

UNIT – II

3. **ECONOMICS AND FINANCING OF AQUACULTURE :**Economic viability; assets and liabilities; cost-return analysis; production costs-variable and fixed costs; operating income; evaluation of farm performance; sensitivity analysis; minimum farm size; gross revenue.
4. Economic feasibility of investment analysis; methods of feasibility analysis – the payback method, net present value method, average rate of return, discounting method; benefit – cost ratio; internal rate of return; cash flow analysis; socio-economic analysis; risk and insurance.
5. Economics of carp, prawn and shrimp breeding farms and production farms.
6. Role of banks, central organizations and other funding agencies in the growth and development of aquaculture.

UNIT – III

7. **FARM MANAGEMENT:** Concepts of economic principles of farm management; application of farm management principles in aquaculture.
8. **MARKETING :**Economics of fish markets; marketing and resource management; co-operatives and their importance in fish production and marketing; export oriented growth policies; fisheries projects and fish resources; institutional and management issues; planning and financing schemes for fisheries; legal and environmental issues.
9. **FISHERIES EXTENSION:** Extension education-objectives and principles; role of extension in community development; rural development strategies – programmes for weaker sections of the community; fisheries as a tool in rural development; extension strategies and methodologies; employment generation.

UNIT – IV

10. **REMOTE SENSING:** Utility of remote sensing techniques for the identification of suitable grounds for aquaculture and for obtaining data on geographical information system (GIS); role of remote sensing in the assessment of aquatic pollution.

11. **ASSESSMENT OF ENVIRONMENTAL HAZARDS AND IMPACTS OF AQUACULTURE :**Concept of clean environment; impact of fish farming on the aquatic ecosystem; impact of fish farming on socio-economic and socio cultural environment; effects of aquatic pollution on fish farming; environmental impact assessment studies (EIA); ecofriendly technologies in aquaculture.

SUGGESTED READING :

1. Korakandy, R., 1996. **Economics of Fisheries Management – A Critique in the Third World Perspective**. Daya Publishing House, New Delhi.
2. Allen et. al (Eds). 1984. **Bio-Economics of Aquaculture**. Elsevier.
3. Hepher, B. and Pruginin, Y. 1981. **Commercial Fish Farming**.
4. Pillay, T. V. R., 1993. **Aquaculture : Principles and Practices**. Fishing News Books.
5. Kothar, P., 1988. **Marketing Management**. Prentice Hall, Inc.

6. Adivi Reddy, A. 1976. **Extension Education**. Sree Lakshmi Press, Bapatla, India.
7. Joshi, M. V., 1996. **Economics of Fisheries**. Daya Publishing House, New Delhi.
8. Girirappa, S., 1995. **The Role of Fisheries in Rural Development**. Daya Publishing House, New Delhi.
9. Guidelines for the **Promotion of Environmental Management of Coastal Aquaculture Development**, FAO Fisheries Technical Paper 328. 1992. Rome.
10. Pillay, T. V. R. 1996. **Aquaculture and the Environment**. Daya Publishing House, New Delhi.
11. FAO, 1995. **Geographical Information Systems and Remote Sensing in Inland Fisheries and Aquaculture**. Daya Publishing House, New Delhi.

COURSE OUT COMES

CO1 Understand the Marketing and Aquaculture Economics
CO2 Acquire knowledge on Financing of Aquaculture
CO3Creating awareness on Farm Management and Marketing
CO4 Knowledge on Remote sensing
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	2	2	1	3	3	1	1	1	1	1	1	1
CO2	2	1	1	3	3	2	3	1	1	1	1	1
CO3	1	1	1	3	2	3	1	1	1	1	2	1
CO4	1	1	1	1	1	1	1	1	1	1	1	1

H-High-3, M- Medium-2, L- Low-1

SKILL ORIENTED COURSE - 3 (B) - AQC 205 : LIMNOLOGY

COURSE OBJECTIVE

To enable the students to

1. Acquire knowledge on dynamics of lentic and lotic environments
2. Understand classification of planktons
3. Know aquatic plants
4. Understand artificial enrichment

SKILL ORIENTED COURSE - 3 (B) - AQC 205 : LIMNOLOGY

UNIT-I

Introduction to limnology: inland water types, their identities and distribution; ponds and lakes;

streams and rivers; dynamics of lentic and lotic environments.

Lakes - their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena;

UNIT-II

Biological relations: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton;Distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton: seasonal changes of body form in planktonic organisms; food of planktonic organisms. Primary productivity;

UNIT-III

Aquatic plants: character, classification, zonation, seasonal relations, quantity produced chemical composition distribution in different waters, limnological role.

Nekton: composition, distribution, movements.

Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna.

UNIT-IV

Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment.

Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments. influence of currents; plant growth; plankton; nekton; benthos; temporary and head waters streams; ecological succession.

SUGGESTED READING :

1. Santhanam, R. 1993. **A Manual of Fresh Water Ecology : An Aspect of Fishery Environment.** Daya Publishing House, New Delhi.
2. Pillai, N. K. 1993. **Marine Biology and Ecology.** Daya Publishing House, New Delhi.
3. Reid, G. K. and R. D. Wood. 1976. **Ecology of Inland Waters and Estuaries** D. Van Nostrand Company.
4. Kormondy, E. J. 1996. **Concepts of Ecology.** Prentice Hall of India Pvt. Ltd. New Delhi.
5. Cole, G. L. 1954. **Text Book of Limnology**. The C. V. Mosloy Co.,
6. Odum, E. P. 1996. **Fundamentals of Ecology**. 3rd Edn. Natraj Publishers, Dehradun.
7. Santhanam, R. and A. Srinivasan. 1994. **A Manual of Marine Zooplankton.** Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Pillai, N. K. 1986. **Introduction to Planktonology**. Himalaya Publishing House, Mumbai.
9. Balakrishnan Nair, N and D. M. Thampy. 1980. **A Text Book of Marine Ecology.** Mc Millan Co. of India Ltd.

COURSE OUT COMES

After completion of this course, students

CO1. Understand the Limnology
CO2. Acquire knowledge on Biological relations
CO3. Creating awareness on Aquatic plants
CO4. Knowledge on Biological Productivity
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	1	2	3	3	2	2	1	1	1	2	3
CO2	3	2	3	3	3	2	1	1	1	1	2	3
CO3	3	1	3	2	3	1	3	1	1	1	3	3
CO4	3	2	3	2	3	3	3	1	1	1	3	3

SKILL ORIENTED COURSE - 4 (A)- AQC 206 : FISH PROCESSING TECHNOLOGY

COURSE OBJECTIVE

To enable the students to

1. Understand the Chemical composition of fish and shell fish
2. Know the principles and working application of fish preservations and package
3. Ac quire knowledge on different types of aquaculture freezers
4. Knowledge on processing of low cost fish and by products.

SKILL ORIENTED COURSE - 4 (A)- AQC 206 : FISH PROCESSING TECHNOLOGY

UNIT-I

Chemical composition of fish and shellfish: moisture, protein, fat, carbohydrates, ash etc. Microbiology of fresh and processed fish: Morphology of bacteria: growth and reproduction of bacteria: effect of environmental factors like temperature, pH, oxygen, moisture, etc.

UNIT-II

Common bacteria present in fish; identification and isolation. Bacteria of sanitary significance. **Handling of fish:** spoilage of fish and shellfish; effect of temperature on fish spoilage, use of ice;

UNIT - III

Solid carbon dioxide and liquid nitrogen in fish preservations; containers for packaging and transportation of fish, handling on board fishing vessels and on shore; use of chemical preservatives and irradiation in extending shelf life of fish and shell fish.

Canning: Principles of canning; canning materials; handling and preparation of fish and shellfish for canning; spoilage of canned fish; chemical and microbiological spoilage and their prevention.

Curing: Salting of fish-principles and practices; pickling; smoked fish; spoilage of cured fish.

UNIT-IV

Freezing of fish: Techniques of freezing; different types of freezers; changes during freezing and storage of fish; effects of freezing on proteins, lipids and bacteria, spoilage of frozen fish and shellfish; denaturation of proteins, lipid hydrolysis; fat oxidation, protection of frozen fish; glazing and wrapping; use of anti-oxidants; thawing of frozen fish, double freezing of fish; storage, transportation and distribution of frozen fish, industrial methods of freezing fish and shellfish; production and freezing of fish fillets, minced meat and fish fingers.

Byproducts: processing of low cost fish, minced meat, fish oil, fish meal, fish sausages, isinglass, glue, fish silage, chitosan, chitin pearl essence, alginates, agar and corals.

Text Books:

1. R.R. Colwell (ed): Biotechnology in Marine Science, 1982.
2. Aitikin, A: Fish handling & processing 2nd edition, Min. Agr. Fish and Food, U.K.,1982.
3. Borgstorm, G. : Fish as Food Vol. I, III and IV, Academic Press, 1961, 1965
4. Brandi, A.V.: Fish catching methods of the World, 3rd edition, Fishing News

Books ltd. 1984.
5. Connel, J.J.: Control of Fish Quality, Fishing News Books Ltd., 1975.
6. Sanisburry, J.C.: Commercial Fishing Methods, Fishing News Books Ltd., 1971.

References:

1. *Connell J.J.* : Advances in fish science and technology, Fishing News Books Ltd., 1980.
2. Nedelec C.: FAO catalogue of small scale fishing gear, FAO (FNB)

COURSE OUT COMES

After completion of this course, students

CO1 Understand the Chemical composition of fish and shell fish
CO2 Acquire knowledge on Common bacteria present in fish
CO3 Creating awareness on fish preservation and packaging
CO4 Knowledge on Freeing of fish and by products

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	2	3	2	3	2	1	1	1	3	3	3
CO2	2	1	2	1	1	1	3	3	1	3	2	1
CO3	3	1	3	3	1	1	3	1	1	3	3	3
CO4	1	1	1	1	1	2	1	1	1	3	3	3

H-High-3, M- Medium-2, L- Low-1

SKILL ORIENTED COURSE - 4 (B) - AQC 206:POLLUTION AND TOXICOLOGY

COURSE OBJECTIVE

To enable the students to

1. Ac quire knowledge on methods of toxicity testing factors
2. Understand marine environment sewage pollution
3. Understand Heavy metal pollution
4. Verify Oil pollution ,biological impacts

SKILL ORIENTED COURSE - 4 (B)- AQC 206:POLLUTION AND TOXICOLOGY

UNIT-I

Marine Pollution-definition- role of GESAMP- major pollutant- sources, transport path, dynamics. Toxicology- lethal and sub lethal effects of pollutants to marine organismsbioconcentration, bioaccumulation and biomagnifications- methods of toxicity testingfactors influencing toxicity-synergistic and antagonistic effects- role of microcosms and mesocosms.

UNIT II

Sewage pollution industrial, agricultural and domestic impact on marine environment, treatment methods. Detergents- composition- eutrophication and ecological significance- Plastics and Litter source and impact in the marine environment.

UNIT III

Heavy Metal pollution- sources, distribution, fate- analytical approaches; Pesticide pollution classification, sources, distribution, fate and ecological impacts with special reference to marine fishes, birds and mammals.

UNIT- IV

Oil Pollution- composition, sources, biological impacts on fishes, birds, mammals, treatment

techniques. Thermal pollution- sources - uses of waste heat role of biocides, chlorine ecological impacts. Radioactive pollution- sources (natural and artificial) biological effects of radiation.
Environmental monitoring methods for critical pollutants-objectives status limitations biological indicators - natural bioaccumulations (mussel watch water quality assessment. Use of analytical instruments AAS, ICP, GLC, Spectrofluorometer for analyzing Petroleum hydrocarbon, Pesticides, Heavy metals etc.

Text Books

1. Clark R.B 1992. Marine pollution 3rd edition Clavendron, Press Oxford.
2. Williams 1996. Introduction to Marine Pollution Control. John Wiley.
3. Michael J. Kennish 1994. Practical Handbook on Estuarine and Marine Pollution.

Reference Books

1. Johnston, R. (ed), 1976. Marine Pollution, Academic Press, London.
2. Goldberg, E. D. 1974. The Health of the oceans, UNESCO Press. Paris.
3. Park, P .K, Kester D.R., J.W. Deudall and B.H Ketchum, 1983. Wastes in the Ocean. Vols. 1 to 3. Wiley Interscience Publishers, New York.

COURSE OUT COMES

After completion of this course, students
CO1 Understand the Marine pollution
CO2 A quire knowledge on Sewage pollution
CO3 Creating awareness on Heavy metal pollution
CO4 Knowledge on Oil pollution

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	2	2	2	3	3	3	3	1	1	1	3
CO2	3	2	2	2	3	3	3	3	1	1	1	3
CO3	3	2	2	2	3	3	3	3	1	1	1	3
CO4	3	2	2	2	3	3	3	3	1	1	1	3

H-High-3, M- Medium-2, L- Low-1

PRACTICAL – IV - AQC 207: PHYSIOLOGY OF FINFISH AND SHELLFISH

1. Effect of size, sex and salinity on oxygen consumption.
2. Effect of eyestalk ablation on oxygen consumption in crab.
3. Estimation of excretory ammonia.
4. Collection and preservation of pituitary gland in fish
5. Induced breeding in fish through hypophysation.
6. Estimation of haemolymph chlorides with reference to salinity in crab.
7. Effect of thyroxine on fish growth.
8. Determination of fish age.
9. Estimation of gonado somatic index and fecundity in fish

OOTC – AQC : 208: OPEN ONLINE – TRANSDICIPLINARY COURSE – 2

AUDIT COURSE - AQC : 209 INDIAN KNOWLEDGE SYSTEMS - 2

III SEMESTER

CORE COUSE- 7– AQC 301: MICROBIOLOGY AND FISH PATHOLOGY

COURSE OBJECTIVE

To enable the students to

1. Understand the Principles and scope ofMicrobiology
2. Classify Microbiology and Fish Pathology
3. Summarize Food Microbiology, Organize Fish farming and public health techniques
4. Examine Diseases and Nutritional Deficiency diseases in Aquaculture

CORE COUSE- 7 – AQC 301: MICROBIOLOGY AND FISH PATHOLOGY

UNIT – I

1. **INTRODUCTION TO MICROBIOLOGY:** Scope and definition; major groups of microorganisms and their characteristics; classification and identification of microorganisms; fine structure, morphology and culture characteristics of bacteria and viruses.

UNIT – II

2. **SOIL AND AQUATIC MICROBIOLOGY:** Study of role of microorganisms in soil and water; soil and water probiotics and their importance.
3. **FOOD MICROBIOLOGY:** Role of microorganism's in preservation and spoilage of fisheryproducts and food stuffs.

UNIT – III

10. **VIRAL AND BACTERIAL DISEASES IN FINFISH AND SHELLFISH:** Causes, symptoms, diagnosis, prophylactic and therapeutic measures.

5.PROTOZOAN AND FUNGAL DISEASES: Causes, Symptoms, diagnosis and preventive measures.

UNIT – IV

6.CRUSTACEAN AND HELMINTH PARASITES IN FISH:

Diseases caused by isopods and learnea; diseases caused by dactylogyrus and monocoelium; trematode larvae, nematodes and fish leeches – clinical picture, symptoms and prophylaxis. **Tumours in fish** – Epitheliomas and fibroepitheliomas, epitheliomapapulosum; papillomas; adenomas; carcinomas; hepatoma and melanosarcomas.

7.NUTRITIONAL DEFICIENCY DISEASES: Metabolic disturbances; vitamin deficiency; gastritis and enteritis; aflatoxins in feed.

11. **ENVIRONMENTAL STRESS DISEASES:** Lack of oxygen; gas bubble disease; pH; acidosis and alkalosis; intoxications; hydrocyanic acid, free chlorine, metals, phenol and temperature, disturbances.
12. Fish farming and public health; techniques of curative baths and mass injections.

SUGGESTED READING :

1. David Freifelder. 1987. **Microbial Genetics,** Narosa Publishing House.
2. Michael J. Pelczar, JR. E C. S. Chan & Noel R. Krieg :**Microbiology,** Tata McGraw Hill Edition. 5th Edition.
3. Dubey, R. C. & D. K. Maheswari (2000). **Text Book of Microbiology,** S. Chand & Company Ltd. New Delhi.
4. Sharma, P. D. (1988). **Microbiology**, Rastogi Publications, Meerut, India.
5. Biswas, K. P. 1995. **Prevention and Control of Fish and Prawn Diseases**. Daya Publishing House, New Delhi.
6. Luky. 1994. **Methods for the Diagnosis of Fish Disease**. Daya Publishing House, New Delhi.
7. Kabatza, Z. 1985. **Parasites and Diseases of Fish Cultured in the Tropics**. Taylor and Frances, London.
8. Van Duijn, C. 1973. **Diseases of Fishes**. London Life Books Ltd.
9. Conroy, D. A. and Herman, R. L. 1968. **Text Book of Fish Diseases**. T.F.H. (Gt. Britain) Ltd.
10. Das, M. K. And R. K. Das. 1997. **Fish and Prawn Diseases,** Inland Fisheries Society of India, Barrackpore.
11. Chakrabarthi, N. M. 1995. **Diseases of Cultivable Fresh Water Fishes and Their Control**. Daya Publishing House, New Delhi.
12. Ellis, Anthony E. (Edr.) 1995. **Fish and Shell Fish Pathology**. Daya Publishing House, New Delhi.

COURSE OUT COMES

After completion of this course, students

CO1 Understand the Characteristics of bacteria and viruses

CO2 Acquire knowledge on Aquatic Microbiology
CO3 Creating awareness on Diseases in finfish and shellfish
CO4 Knowledge on Parasites in fishes, Nutritional deficiency diseases and Environmental stress diseases

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	2	3	3	3	3	3	3	3	3	2	2
CO2	3	3	1	1	2	2	3	3	3	3	1	3
CO3	2	2	2	2	2	3	3	3	3	3	2	1
CO4	3	3	3	3	3	3	3	3	2	3	2	2

H-High-3, M- Medium-2, L- Low-1

CORE COURSE -8 (A) - AQC 302: FISH IMMUNOLOGY

COURSE OBJECTIVE

To enable the students to

1. A quire knowledge on fish immunity
2. Understand the structure and functional aspects, Immunoglobulin
3. Know the principles and working application of Immuno diffusions
4. Comprehensive knowledge on Immunising fish

CORE COURSE -8 (A) - AQC 302: FISH IMMUNOLOGY

UNIT – I

1. **IMMUNE SYSTEM IN FISH:**Innate & acquired immunity- Advanced, primitive and unique features; specific and non-specific defence mechanisms.
2. **LYMPHOID SYSTEM IN FISH :**Stem cells, thymus, spleen, head, kidney and other lymph glands; lymphocyte subpopulation in fish

UNIT – II

3. Antigen - Types - Heptanes, Ag - Ab interactions
4. **IMMUNOGLOBULIN:** IgM structure and functional aspects; other Igs; Ig mediated immunity; antibody diversity.
5. **COMPLEMENT SYSTEM :**Classical & alternative

UNIT – III

6. **NON IG MEDIATED HUMORAL IMMUNITY:**Antigrowth factors, antienzymes, lysins, complement (properdin path way); agglutinins and opsonins.
7. **CRUSTACEAN IMMUNE SYSTEM**
8. **CELL MEDIATED IMMUNITY:**MHS class I & II, allograft rejection; anaphylactic hypersensitivity; delayed type hypersensitivity, lymphokines. Antibody probes in diagnosis of fish diseases & immunodiagnostic kits.

UNIT – IV

9. **IMMUNOTECHNOLOGY:** Immunodiffusions, immuno electrophoresis, radio immunoassay, ELISA, MLR, Hybridoma technique, immunoblotting.
10. **CONCEPT OF IMMUNISING FISH:**Vaccines and immunostimulants in fish adjuvants; features of vaccine development; vaccine delivery systems; identification of disease problems and potential vaccines; case study describing vaccination for furunculosis; commercial considerations. Management of aquacultural practices through immunological approach.

SUGGESTED READINGS :

1. Nandini Shetty. 2000. **Immunology: Introductory Text Book** - New Age International (p) Ltd., Chennai.
2. Karunasagar, I. 1999. **Aquaculture and Biotechnology**. Oxford IBH Publishers
3. Goldsby. R.A., J. K. Thomas and B. A. Barbara, 2000. **Kuby Immunology**, IVthEdn., W. H. Freeman and Co., New York.
4. **Fish & Shell Fish Immunology.** 1992. Vol. 2, No.1, Academic press.
5. Kimbell, E. 1988. **Fundamentals of Immunology**.

COURSE OUT COMES

To enable the students to

CO1 Understand the Immunity system in fish

CO2 Acquire knowledge on Immunoglobulin structure and functions

CO3 Creating awareness on Humoral immunity, Crustacean immune system and cell mediated immunity

CO4 Knowledge on Immuno technology and concept of immunizing fish

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	3	2	2	2	2	3	3	3	3	2	2
CO2	1	1	1	1	1	1	3	3	3	3	1	1
CO3	3	2	2	2	2	2	3	3	3	3	1	1
CO4	3	2	2	2	2	2	3	3	3	3	1	1

H-High-3, M- Medium-2, L- Low-1

CORE COURSE -8 (B) - AQC 302 :FISH BREEDING AND HATCHERY MANAGEMENT

COURSE OBJECTIVE

To enable the students to

1. Understand the life cycle of important shell fishes
2. Know Induced maturation in penaeus monodon by eye stalk ablation
3. Knowledge on reproductive hormones in crustaceans
4. Understand health management hatcheries

CORE COURSE -8 (B) - AQC 302 :FISH BREEDING AND HATCHERY MANAGEMENT

UNIT-I

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon, P. vannamei, Macrobrachiumrosenbergii, Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, sea horse, horse-shoe carb, Sepia, Loligo, cray fish etc.).

UNIT-II

Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachiumrosenbergii*and *Penaeus monodon.*

Induced maturation in *Penaeus monodon* by eye stalk ablation;

UNIT-III

Reproductive physiology. Reproductive harmones in crustaceans; Brood stock management of *Penaeus monodon, P. vannamei* and *Macrobrachiumrosenbergii*.

UNIT-IV

Breeding and hatchery management of Penaeus monodon and Macrobrachiumrosenbergii. Breeding and hatchery management of crabs and bivalves. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

REFERENCE BOOKS:

1. MPEDA, **Hand Book on Aquafarming** , Shrimps, lobsters, mudcrabs (1996).
2. Nandi, N. C. and S. K. Pramanik. 1994. **Crabs and crab Fisheries of Sundarban**. Hindustan Publishing Corporation.
3. Pillay, T. V. R. 1988. **Aquaculture, Principles and Practices**. Fishing News Books.
4. Piska, R. S. 1999. **Fisheries and Aquaculture.** Lahari Publications, Hyderabad.
5. Pandian, T. J. 2001. **Sustainable Indian Fisheries.** National Academy of Agricultural Sciences.
6. Sahoo, D. and S. Z. Qasim. 2002. **Sustainable Aquaculture.** APH Publishing Corporation, New Delhi – 110 002.
7. MPEDA – Hand Book on Aquafarming – **Fish Processing, Quality Control & Marketing**. 1995. Kochi, India.

COURSE OUT COMES

After completion of this course, students

CO1. Understand the Natural seed resources
CO2.Acquire knowledge on Sexual maturity and breeding seasons of different species
CO3. Creating awareness on Reproductive physiology, Reproductive harmones in crustaceans
CO4. Knowledge on Breeding and hatchery management of penaeus monodon and Macrobrachiumrosenbergii
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	1	1	1	3	3	3	1	2	1	1	1
CO2	2	2	1	1	1	3	3	3	3	3	1	1
CO3	2	1	1	1	3	3	3	3	3	1	1	1
CO4	3	3	3	1	3	1	1	1	1	3	3	3

H-High-3, M- Medium-2, L- Low-1

CORE COURSE -9 (A) - AQC 303 : CELL BIOLOGY AND GENETICS

COURSE OBJECTIVE

To enable the students to

1. Ac quire knowledge on physic chemicals basis of heredity
2. Understand the principles of genetic rationale in fish breeding
3. Ac quire knowledge on Natural hybridization in fishes and Genetic diversity in fishes
4. Knowledge on sex chromosomes in fishes

CORE COURSE -9 (A) - AQC 303 : CELL BIOLOGY AND GENETICS

UNIT – I

1. STRUCTURE OF PROKARYOTIC AND EUKARYOTIC CELLS: ultra-structure of animal cell;cell differentiation in animal cells. Structural organization of plasma membrane; membrane protein, cytoskeletal proteins; types of cell functions – transport of nutrients, osmosis and active transport.

2.CELL ORGANELLES: Organization and functions of endoplasmic reticulum, golgi complex, lysosomes, mitochondria, ribosomes, nucleus, and vacuoles.

UNIT – II

3. CHROMOSOMES: Structural organization, nucleosomes, chromonema, euchromatin, heterochromatin, centromere, kinetochore, telomeric organization.

4. Cell cycle, mitosis and meiosis; cell senescence and death.

UNIT – III

5. PRINCIPLES AND PHYSICO CHEMICAL BASIS OF HEREDITY: Phenotype and genotype,chromosomal basis of heredity; Mendel's laws of inheritance, **mutations** – types of mutations,molecular basis of mutation and its importance, chemical and physical mutagens, site directed mutagenesis.

6. GENETIC RATIONALE IN FISH BREEDING: Random genetic drift, inbreeding, measures to prevent random genetic drift and inbreeding; selective breeding programmes - selection of species and traits, choice of breeding strategy, methods of selection and evaluation of selection response, impacts of selective breeding programmes on aquaculture productivity.

UNIT – IV

7. Natural hybridization in fishes, consequences and evolutionary impacts of hybridization; artificial hybridization – hybridization in Indian carps and Chinese carps. Genetic diversity in fishes – natural genetic variation in fishes, stock concept, measuring genetic variation, importance of genetic diversity; threats to fish genetic diversity – fishing pressure, physical modification of habitat and pollution load, introduction of exotic fishes; genetic management of natural fish populations – goals and tasks and conservation approaches.

8. CYTOGENETICS OF FISHES: Chromosome preparation, staining of chromosomes, chromosome banding techniques (NOR banding, C-banding,G and R banding, Fluroscence*insitu* hybridization), trends in karyotype evolution, sex chromosomes in fishes.

SUGGESTED READING :

1. B. K. Padhi & R. K. Mandal, **Applied Fish Genetics**. Fishing Chimes, Vishakapatnam.
2. Chourrout, D. 1987. **Genetic manipulations in fish: reviews of methods. In: Selection, hybridization and genetic engineering in aquaculture** (Ed. Tiews, K.) Vol. 2, Heenemann GmbH gesellschaft, Berlin. Pages 111 – 126.
3. Carvalho G. R. and L. Hauser (1995). **Molecular Genetics in Fisheries**. Chapman and Hall, London.
4. D. Frifielder :**Microbial genetics.**
5. Alberts et al: **Molecular Biology of cells.**
6. H. Lodish, A. Berk, S. L. Zipursky, P. Matsudaria, D. Baltimore and J. Damell. **Molecular Cell Biology**. W. H. Freeman & company, New York.

COURSE OUT COMES

After completion of this course, students

CO1 Understand the structure of prokaryotic and eukaryotic cells and cell organelles

CO2 Acquire knowledge on Chromosomes and Cell cycle

CO3 Creating awareness on Genetic rationale in fish breeding and physico chemical basis of heredity

CO4 Knowledge on Natural hybridization and cytogenetics of fishes

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	2	2	2	2	2	2	2	2	3	3	2	2
CO2	2	2	1	1	1	2	1	1	3	3	3	1
CO3	1	1	2	1	1	1	1	1	3	3	1	1
CO4	1	1	2	1	1	1	1	1	3	3	1	1

H-High-3, M- Medium-2, L- Low-1

CORE COURSE -9 (B) - AQC 303: BIOINFORMATICS IN AQUACULTURE

COURSE OBJECTIVE

To enable the students to

5. Understand bioinformatics applications in aquaculture
6. Acquire knowledge on application of genetic maps
7. Comprehensive knowledge on automated tools for phylogenetics analysis
8. Understand applications of microarray technology

CORE COURSE -9 (B) - AQC 303: BIOINFORMATICS IN AQUACULTURE

UNIT - I

1. BIOINFORMATICS AN OVERVIEW:Definition and objectives of bioinformatics, major bioinformatics databases, data integration and data analysis, molecular biology and bioinformatics, central dogma of molecular biology, important definitions related to central dogma and overview of bioinformatics applications.

2. INFORMATION SEARCH AND DATA RETRIEVAL: Introduction, tools for web search, data retrieval tools, data mining of biological data bases.

UNIT – II

3. GENOME ANALYSIS AND GENE MAPPING: Genome analysis, gene mapping, sequence assembly problem, genetic mapping and linkage analysis, physical maps, cloning the entire genome, genome sequencing, applications of genetic maps.

4. TOOLS FOR SIMILARITY SEARCH AND SEQUENCE ALIGNMENT: Fasta, Blast, Filtering and gapped BLAST, PSI – BLAST, Comparison of running time for various programmes.

UNIT – III

5. ALIGNMENT OF PARIS OF SEQUENCES: Introduction, biological motivation of alignment problems, methods of sequence alignments, using scoring matrices, measuring sequence detection efficiency.

6. ALIGNMENT OF MULTIPLE SEQUENCES: Introduction, methods of multiple sequence alignment, evaluating multiple alignments; phylogenetic analysis – methods of phylogenetic analysis, tree evaluation, problems in phylogenetic analysis, automated tools for phylogenetic analysis.

UNIT – IV

7. GENE IDENTIFICATION AND PREDICTION: Introduction, basis of gene prediction, pattern recognition, gene prediction methods, other gene prediction tools.

8. GENE EXPRESSION AND MICROARRAYS: Introduction, working with DNA microarrays, clustering gene expression profiles, data sources and tools 2for microarray analysis, applications of microarray technology.

9. GENERAL APPLICATIONS OF BIOINFORMATICS IN AQUACULTURE.

SUGGESTED READINGS :

1. S. C. Rastogi, N. Mendiratta and P. Rastogi. 2004. **Bioinformatics – Concepts, Skills and Applications**. CBS Publishers and Distributors, New Delhi.

2. Computers Today by Suresh K. Basandra 1999. Published by Galagotia Publications, Pvt. Ltd., New Delhi.

3 Microsoft Office, by Setultz, 1997.

4. Database Processing by D. M. Kroenke, Galgotia Publications, 1990.

5 Claverie J.M and Notredame C.2003 Bioinformatics for dummies. Wiley Editor.
6 Letovsky, S.I.1999 Bioinformatics. Kluwer Academic Publishers.
7 . Baldi, P and Brunk, S. 1998 Bioinformatics. The MIT press.
8 Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press.
9.Introduction to Biostatistics – By Sokal-Rohlf (2nd Edn) Freeman International Editor 1973.
10. Bio-Statistics – An introductory Text-Goldstein, A The Macmillan Co., New York, 1971.
11. Statistical Analysis in Biology by Mather, K Chapman and Hall, London, 1972.
12. Probit Analysis by Finney, D. J. S. Chand & Co., Ltd., New Delhi.
13. Biostatistics by Lewis Alvin 1971. Affiliated East West Press Pvt., Ltd., New Delhi.
14. Statistical methods in Biology by Bailey Norman T. J. 1965. The English Language Book Society & The English
University Press Ltd.

COURSE OUT COMES

After completion of this course, students

CO1. Understand the Bioinformatics

CO2.Acquire knowledge on Genome analysis and gene mapping

CO3. Creating awareness on Alignment of pairs of sequences

CO4.Knowledge on Gene Identification and prediction

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	1	1	1	1	1	2	2	2	3	3
CO2	1	1	1	1	1	1	1	2	2	2	3	3
CO3	1	1	1	1	1	1	1	2	2	2	3	3
CO4	1	1	1	1	1	1	1	2	2	2	3	3

H-High-3, M- Medium-2, L- Low-1

PRACTICAL – V – AQC 304: MICROBIOLOGY AND FISH DISEASES

1. Preparation and sterilization of microbial media.
2. Quantitative determination of microorganisms by dilution plate technique.
3. Staining methods of microorganisms.
4. Antibiotic sensitivity.
5. Isolation and characterization of intestinal pathogens.
6. Measurement of the size of the cell.
7. Collection and Preservation of Diseased Fish.
8. External & Internal examination of diseased finfish and shellfish.
9. Maceration and squash preparation of organs and microscopic observation.
10. Identification of disease causing microbes.
11. Identification of various diseases in finfish and shellfish
12. Preparation of chromosomes from gill epithelium
13. Observation of chromosomes from fish tissues.
14. Preparation of chromosomes from scale and fin epithelium.
15. Induction of ploidy variations in different tissues of fish.
16. Chromosomal banding techniques.
17. Observation of meiotic chromosomes from testis.
18. Isolation of DNA from yeast.
19. Isolation of RNA from yeast.
20. Raising antibodies to fish antigen.
21. Immunoelectrophoresis.
22. Double immunodiffusion.

SKILL ORIENTED COURSE – 5 (A) -AQC: 305 - FISH NUTRITION TECHNOLOGY

COURSE OBJECTIVE

To enable the students to

1.Provide knowledge for sustainable aquaculture

2.Provide the students on field exposure to help them in understanding the Aquaculture practices. Effective utilization of aquatic and land resources.

3.Provide the learners an experience in research for Aquaculture production.

4.Enhancing skills of rural youth commercial fish farming and increasing their entrepreneurship opportunities, Providing means of livelihood through commercial and industrial aquaculture.

UNIT-I: FISH NUTRITION AND FEED TECHNOLOGY 4 Credits

Module I: Nutritional requirements of cultivable fish and shellfish. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Feed storage, use of preservatives and antioxidants.

Module II: Feed evaluation - feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value.

Module III: Feeding devices and methods. Non-conventional feed ingredients and anti-nutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutritional deficiency diseases.

UNIT- II: FEED MANAGEMENT&ECONOMICS 4 Credits

Module I: Feed Manufacture: Feed formulation and processing, On-farm feed manufacture, Commercial feed manufacture, Feed storage

Module II: Feeding Practices: Supplementary feed–theory and practice, Complete diet - theory and practice, Feeding methods and scheduling, ration size, feed performance and economics. culture and use of different live feed in shellfish hatcheries, Aquarium fish feeds

Module III: Introduction to fisheries economics, Farm production economics – production functions in capture and culture fisheries; Costs and returns – breakeven analysis of fish production system; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, Revenue, profit maximization, measurement of technological change, farm planning and budgeting.

PRACTICALS

4 Credits

1. Cultivable importance of fish & Shell fish Species
2. Practices on pre-stocking and post stocking management.
3. Analysis of water and soil samples.
4. Design and layout of fresh water and brackish water farms, fish and shrimp hatcheries
5. Visit to farms and hatchery.
6. Estimation and calculations of production costs of fish/shrimp farm.
7. Different types of filters.
8. Determination of Temperature, pH, Turbidity.
9. Total Alkalinity and total Hardness.
10. Dissolved Oxygen
11. Estimation of soil organic carbon
12. Estimation of nitrogen in soil.
13. Proximate composition analysis of feed ingredients and feeds.
14. Preparation of artificial feeds using locally available feed ingredients.
15. Estimation of FCR from feeding trials and preparation of feeding table.
16. Estimation of growth parameters from feeding trials
17. Collection, identification and isolation of live food organisms using various techniques
18. Supplementary feeds Identification:

References

1. Mathew Landau. 1995. Introduction to Aquaculture. Daya Publishing House, New Delhi.
2. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications.
3. MPEDA, 1991. Hand Book on Shrimp Farming, Kochi, India.
4. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. Chakrabarti, N. M. 1998. Biology, Culture and Production of Indian Major Carps. Narendra Publishing House, New Delhi.
5. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. Daya Publishing House, New Delhi. Upadhyay, A. S. 1995. A Hand Book on Design, Construction and Equipments in Coastal Aquaculture (Shrimp Farming). Daya Publishing House, New Delhi.
6. Wheaton, F. W. 1985. Aquaculture Engineering. MPEDA, Cochin.
7. MPEDA 1990. Aquaculture Engineering and Water Quality Management. Cochin, India.
    a. You Tube Video
8. De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
9. Guillame J, Kaushik S, Bergot P &Metallier R. 2001. *Nutrition and Feeding of Fish and Crustaceans.* Springer Praxis Publ.
10. Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
11. Halver JE & Tiews KT. 1979. *Finfish Nutrition and Fish feed Technology*. Vols. I, II Heenemann, Berlin.
12. Hertrampf JW & Pascual FP. 2000. *Handbook on Ingredients for Aquaculture Feeds*. Kluwer.
13. Houlihan D, Boujard T & Jobling M. 2001. *Food Intake in Fish*. Blackwell.
14. Lavens P &Sorgeloos P. 1996. *Manual on the Production and Use of Live Food for Aquaculture.* FAO Fisheries Tech. Paper 361, FAO.
15. Nelson DL & Cox MM. 2005. *Lehninger Principles of Biochemistry*. WH Freeman.
16. Huet J. 1986. *A text Book of Fish Culture*. Fishing News Books Ltd.
17. ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
18. Jhingran V.G. 1991. *Fish and Fisheries of India*. Hindustan Publ. Corporation, India.
19. Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
20. MPEDA: *Handbooks on culture of carp, shrimp, etc*.
21. Pillay TVR. 1990. *Aquaculture- Principles and Practices.* Fishing News Books Ltd.,

Course Outcome:

On successful completion of the course, students will be able to:

CO1 Employment in specific area, Expand research ability

CO2 Get the knowledge of different types of Aquaculture practices

CO3 Build up capability in self-employment and income generation

CO4 Apply for various Governments, Non-Government Schemes for establishing an independent aquaculture farm.

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	3	3	3	3	3	3	1	1	1	1	3	1
CO2	3	3	3	1	3	1	2	2	1	1	2	2
CO3	3	3	3	3	3	3	1	1	1	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3

H-High-3, M- Medium-2, L- Low-1

SKILL ORIENTED COURSE – 5 (B) -AQC: 305: ESSENTIALS OF BIOCHEMISTRY

COURSE OBJECTIVE

To enable the students to

1. Acquire knowledge on structure and function of biomolecules
2. Understand enzyme classification and their factors
3. Attain knowledge on vitamins and minerls
4. Understand bioenergetics models and energy budget

SKILL ORIENTED COURSE – 5 (B) -AQC: 305: ESSENTIALS OF BIOCHEMISTRY

UNIT – I

1. BIOMOLECULES

A brief account of structure and function of protein, lipid and carbohydrate.

UNIT – II

2. ENZYMES

Nomenclature and classification; chemical nature of enzymes; coenzymes, properties of enzymes, factors affecting enzyme activity.

UNIT – III

3.METABOLISM

Interconversions of protein, lipid and carbohydrates; A general account of vitamins and minerals and their importance.

UNIT – IV

4. BIOENERGETICS

Definition and scope; bioenergetics model; structure of an energy budget; components of the energy budget – measurement of components; faecal losses – the absorption efficiency; excretory loses– the assimilation efficiency; metabolic loses; effects of environmental factors on metabolism – temperature, salinity, oxygen and other abiotic factors; examples of energy budgets.

SUGGESTED READINGS :

1. Furton, H. S. and S. Simonds. 1958. **General Biochemistry.** John Wiley and Sons, New York.
2. Murray et. al. 2002. **Harper's Biochemistry** 25thEdn, Mc Grew Hill.
3. Nelson, D. L. and Cox, M. M. 2000. **Lehninger Principles of Biochemistry.** MacMillan Worth Publishers.
4. Robert J. Wootton. 1991. **Ecology of Teleostean Fishes.** Chapman & Hall.
5. Sibly, R.M. and Calow, P.1986. **Physiological Ecology of Animals.** Blackwell, Oxford.

COURSE OUT COMES

After completion of this course, students

CO1 Understand the Biomolecules
CO2 Acquire knowledge on Enzymes
CO3 Creating awareness on Metabolism
CO4 Knowledge on Bioenergetics
CO-PO MAPPING

POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO11	PO12

COS										10		
CO1	2	1	3	1	1	2	2	1	1	1	3	3
CO2	2	1	3	1	1	2	2	1	1	1	3	3
CO3	2	1	3	1	1	2	2	1	1	1	3	3
CO4	3	1	3	2	2	3	2	1	1	1	3	1

H-High-3, M- Medium-2, L- Low-1

SKILL ORIENTED COURSE – 6(A) -AQC: 306: COMPUTER APPLICATIONS, INFORMATION TECHNOLOGYAND BIOSTATISTICS IN AQUACULTURE

COURSE OBJECTIVE

To enable the students to

1. Understand the classification of computers
2. Knowledge on computer application
3. Understand the scope of Biostatistics in aquaculture
4. Understand the statistical analysis in research

SKILL ORIENTED COURSE – 6 (A) -AQC: 306: COMPUTER APPLICATIONS, INFORMATION TECHNOLOGYAND BIOSTATISTICS IN AQUACULTURE

UNIT- I

1.INTRODUCTION TO COMPUTER

History of computers, classification of computers, computer generations; Input, output processing and storage devices – Floppy disk, hard disk, CD-ROM, DVD. Operating system – types of operating systems – MS DOS, WINDOWS; MS – ACCESS, FOXPRO.

UNIT- II

2.COMPUTER APPLICATIONS

Computer Graphics – graphic generation methods, uses of computer graphics, graphic forms; Internet access tools, Web searching, e-mail, File Transfer Protocol 9 FTP); Word processing and presentation software MS- WORD and MS- POWERPOINT, MS – EXCEL; Use of commonly available statistical packages, such as SPSS ANOVA etc.

UNIT – III

3. INTRODUCTION AND SCOPE OF BIOSTATISTICS

Definition and scope, collection, tabulation and presentation of data; measures of central tendency – mean, median and mode; measures of dispersion, mean deviation, standard deviation, co- efficient of variation; curve fitting; correlation and regression.

UNIT – IV

4. STATISTICAL ANALYSIS:

Normal probability distribution and its applications; students t- test; correlation coefficient; regression

co-efficient; F-distribution; X^2 distribution; analysis of variance (ANOVA);Probit analysis.

SUGGESTED READINGS :

1. **Computers Today** by Suresh K. Basandra 1999. Published by Galagotia Publications, Pvt. Ltd., New Delhi.
2. **Microsoft Office**, by Setultz, 1997.
3. **Database Processing** by D. M. Kroenke, Galgotia Publications, 1990.
4. **Introduction to Biostatistics** – By Sokal-Rohlf (2nd Edn) Freeman International Editor 1973.
5. **Bio-Statistics** – **An introductory Text-**Goldstein, A The Macmillan Co., New York, 1971.
6. **Statistical Analysis in Biology** by Mather, K Chapman and Hall, London, 1972.
7. **Probit Analysis** by Finney, D. J. S. Chand & Co., Ltd., New Delhi.
8. **Biostatistics** by Lewis Alvin 1971. Affiliated East West Press Pvt., Ltd., New Delhi.
9. **Statistical methods in Biology** by Bailey Norman T. J. 1965. The English Language Book Society & The English University Press Ltd.

COURSE OUT COMES

After completion of this course, students

CO1 Understand the Introduction to computer
CO2 Acquire knowledge on Computer applications
CO3 Creating awareness on Introduction and scope of biostatistics
CO4 Knowledge on statistical analysis
CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	1	1	1	1	1	1	1	1	3	1
CO2	1	1	1	1	1	1	1	1	1	1	3	1
CO3	1	1	1	1	1	1	1	1	1	1	3	1
CO4	1	1	1	1	1	1	1	1	1	1	3	1

H-High-3, M- Medium-2, L- Low-1

SKILL ORIENTED COURSE – 6(B)-AQC: 306: AQUACULTURE BIOTECHNOLOGY

COURSE OBJECTIVE

To enable the students to

1. Understand structure and replication of DNA
2. Acquire knowledge on Hormonal manipulation of genetic sex
3. Comprehensive knowledge on techniques of analyzing the PCR in biotechnology and genetic engineering
4. Acquire knowledge on Bioactive compounds from marine organisms and Cryopreservation of gametes.

SKILL ORIENTED COURSE – 6(B)-AQC: 306: AQUACULTURE BIOTECHNOLOGY

UNIT – I

1. Structure and replication of DNA: Principles of DNA isolation; DNA blotting
2. DNA : Transcription and translation

UNIT – II

3.CHROMOSOMAL ENGINEERING: Genome manipulation, polyploidy, gynogenesis, androgenesis, method of chromosomal manipulation, Induction of ploidy and evaluation.

Hormonal manipulation of genetic sex, strategy of sex reversal, management of hormone treatment, biological effects of sex reversal, integrated approach.Transgenic fish, candidate genes for transfer, making gene constructs, mechanism of gene transfer, characterization of transgenic fish, potential hazards and benefits.

UNIT – III

5. Recombinant DNA and gene cloning – cloning vectors for recombinant DNA, restriction enzymes for cloning, cloning in bacteria and eukaryotes, construction and

screening of genomic and cDNA libraries.

6. Polymerase chain reaction and gene amplification - basic PCR and its modifications; applications of PCR in biotechnology and genetic engineering- DNA polymorphism, DNA fingerprinting, Nucleotide probes, mapping and gene sequencing: RAPD, RFLP. DNA bar-coding.

UNIT – IV

A) PHARMACOLOGY: Prospects – Bioactive compounds from marine organisms: Biomedical potential of marine natural products isolation and mode of action. Eicosonoids and related compounds from marine algae. Antitumour and cytotoxic compounds from marine organisms.

B) Cryopreservation of gametes: Implications of cryopreservation in Aquaculture. Bioremediation: Types of bioremediation and their importance; Role of Probiotics in Aquaculture.

SUGGESTED READINGS :

1. K. Padhi & R. K. Mandal, **Applied Fish Genetics**. Fishing Chimes, Vishakapatnam.
2. P. S. Verma & V. K. Agarwal, 1999. **Concepts of Molecular Biology**,, S. Chand Company Ltd, NewDelhi.
3. Cherfas, N. B. 1981. Gynogenesis in fishes. **In : Genetic bases of fish selection**. (Ed. Kirpichnikov, V. S.), Springerverlag, Berlin, pp. 255 – 273.
4. Hackett, P. B. 1993. **The molecular biology of transgenic fish. In : Biochemistry and Molecular Biology of Fish**, (Eds. Hochachka, P., Mommsen, T.) Vol. 2, Elsevier Science Publishers, Amsterdam, pp. 207 – 240.
5. Leung, L. K. P. and Jamieson, B. G. M. 1991. **Live preservation of fish gametes. In : Fish Evolution and Systematics : Evidence from spermatozoa** (Ed. Jamieson, B. G. M.) pp. 245 –295, Cambridge University Press.
6. Old, R. W. and Primrose, S. B. 1994. **Principles of gene manipulation : An introduction to genetic engineering,** Blackwell Scientific Publications, Oxford.
7. Balasubramanyam, D. et al. 1998. **Concepts in Biotechnology**, University Press.
8.Gupta, P. K. 1999. **Elements of Biotechnology**, Rastogi Publications, Meerut.
9.David H. Attaway and R.Oskar, 1993. **Marine Biotechnology**. Vol. I **Pharmaceutical and Bioactive Natural** Products. Plenum Press, New York & London,500pp.

10.Milton Fingerman. R.Nagabushanam and Man' – Frances Thompson, 1999. Recent Advances in **Marine Biotechnology**, Vol.I – 514pp. Vol.2-313 pp.Vol3-312pp.
11. Ranga, M. M. 1999. **Animal Biotechnology**, Agrobios, Jodhpur, New Delhi.
12.Karunasagar, **Aquaculture and Biotechnology** (for chapters11& 14).
Ranga and Shammi . 1999. **Fish Biotechnology**

COURSE OUT COMES

After completion of this course, students

CO1 Understand the Structure and replication of DNA
CO2 Acquire knowledge on Chromosomal Engineering
CO3 Creating awareness on Recombinant DNA and gene cloning
CO4 Knowledge on Pharmacology

CO-PO MAPPING

POS COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12
CO1	1	1	1	1	2	1	1	2	3	3	3	3
CO2	1	1	1	1	1	1	1	3	3	3	2	2
CO3	1	1	1	1	1	1	1	3	3	3	2	2
CO4	3	2	3	1	1	3	1	1	2	3	3	3

H-High-3, M- Medium-2, L- Low-1

PRACTICAL – VI – AQC : 307

BIOTECNOLOGY AND BIO CHEMICAL ESTIMATATIONS

1. DNA Electrophoresis.
2. Estimation of DNA by Diphenylamine reaction.
3. Determination RNA by orcinol method.
4. Separation of protein through Electrophoresis (PAGE).
5. Separation of eyestalk peptides through HPLC.
6. Absorption spectrum of DNA.
7. Calculation of mean, median mode.
8. Calculation of standard deviation and coefficient of variation.
9. Calculation of Correlation co-efficient.
10. Fitting of regression lines.
11. Application of F-test.
12. Diagrammatic representation of statistical data.
13. Estimation of protein lipid and total carbohydrates in fish tissues
14. Estimation of amino acids and free fatry acids in fish tissues
15. Estimation of oxidative enzymes in fish tissues
16. Estimation of digestive enzymes in fish tissues
17. Estimation of RNA and DNA in fish tissues.

SEMESTER- IV

SL.NO	COURSE	CODE	TITLE OF THE COURSE	H/W	CREDITS	SEE	IA	TOTAL MARKS
1	OOSDC	AQC:401	OPEN ONLINE SKILL DEVELOPMENT COURSES	--	8	--	200	200
2.	PW	AQC :402	PROJECT WORK – Orientation Classes	24	12	300	0	300
*	Conducting classes for competitive exams communication skills UGC/ CSIR and NET/SLET examinations			12	--	--	--	--
			TOTAL	**36**	**20**	**300**	**200**	**500**
			TOTAL SEMESTERS	**144**	**84**	**1320**	**880**	**2200**

*Open Online Skill development Course (OOSDC) – Students can choose any **Two** relevant courses of his / her choice from the online courses offered by governmental agencies like SWAYAM, NPTEL, etc., **to get 8 credits (with 4 credits from each course).**

Note: AQC 402 : PROJECT WORK

Each Student will be under the guidance of a faculty member and the students will put in field-oriented research work which mainly consists of visiting to the field for sample collection, farming in fish and prawn culture, hatcheries, processing units, marketing and aquatic diseases analysing in the laboratory. Data collected is compiled and submitted as a dissertation to the department. During viva – voce the students has to present his/ her work to the panel of examiners. The attendance of the student during project work period is considered were they do in Aqua companies / Industries.

MODEL QUESTION PAPER
M.Sc. DEGREE EXAMINATION
Branch XV – Aquaculture
AQC 101 - Paper – I – CONCEPTS OF AQUATIC ECOLOGY

Time : 3 hours **Maximum : 70 Marks**

PART – A

Answer any **FOUR** questions. Each question carries 5 marks.

(Marks : 4x5=20)

1. Lotic and lentic Ecosystems
2. Zonation of the Sea
3. Thermal Optimum
4. Hypoxia
5. Sulphur Cycle
6. Phytobenthos and Zoobenthos
7. Standing Crop
8. Pyramid of biomasses

PART – B
(4X12.5=50)

Answer **ALL** questions. Each question carries 12.5 marks

9. (a) Discuss indetail ecosystem with all features

(OR)

(b) Write a detailed account on Marine Ecosystem

10. (a) Discuss in detail the physical characterization of water

(OR)

(b)Answer the following

i. Adaptations of animals to varying oxygen tensions

ii. p^H concentration of water

11. (a) Illustrate the Nitrogen cycle and explain the trace elements

(OR)

(b)Discuss in detail the zones of aquatic vegetarian

12. (a) Write a detailed account on productivity

(OR)

(b)Narrate the different steps involved in the dynamics of Aquatic Ecosystem.

MODEL QUESTION PAPER
M.Sc. DEGREE EXAMINATION
Branch XV – Aquaculture
AQC 106 Skill Oriented Course 2 (B) : AQUATIC FOOD SAFETY &QUALITY MANAGEMENT

Time : 3 hours Maximum : 50 Marks

PART – A

Answer any **Five**questions. Each question carries 2 marks.
(Marks : 4x2=10)

1.Intrinsic Quality
2.Fish Spoilage
3.Frozen storage
4.Microbial spoilage
5.Discrimination Tests
6.Good hygienic practices
7. Quality Management
8.Naturally toxic fish

PART – B
(4X10=40)

Answer **ALL** questions. Each question carries 10 marks

9. (a) Describe in detail Quality Deterioration and Extrinsic Quality defects in fish

(OR)

(b)Discuss Uniqueness of seafood quality control.

10. (a) Describe the Fish spoilage and quality assessment.

(OR)

(b) Discuss in detail Microbial spoilage

11. (a) Discuss Recognized specific spoilage organisms

(OR)

(b) Give a detailed account on Freezing process

12. (a) Discuss in detail Quality Assessment of Fish and Fishery Products

(OR)

(b) Give a detailed account on Modern safety and quality assurance methods.