NORTH-EASTERN HILL UNIVERSITY
SHILLONG

B. Sc. (Honours) Fishery Science (Semester system)
2015

Year	Semester	Name of the paper	Paper and Marks	Paper Number	Paper code	Paper wise Marks (Ext+Int)
First Year	1st Semester	Fish Biology and Taxonomy	Paper 1 100	Paper 1A (Theory)	FISC - 101	75 (56+19)
				Paper 1 B (Practical)	FISC- 101 (P)	25 (19+6)
	2nd Semester	Aquatic Ecology	Paper 2 100	Paper 2A (Theory)	FISC- 201	75 (56+19)
				Paper 2B (Practical)	FISC- 201(P)	25 (19+6)
Second Year	3rd Semester	Capture Fisheries	Paper 3 100	Paper 3 A (Theory)	FISC- 301	75 (56+19)
				Paper 3B (practical)	FISC- 301 (P)	25 (19+6)
	4th Semester	Aquaculture	Paper 4 100	Paper-4 A (Theory)	FISC- 401	75 (56+19)
				Paper-4B (Practical)	FISC- 401(P)	25 (19+6)
Third Year	5th Semester	Fishery Technology, Pathology and Extension Education	Paper -5 100	Paper-5 A (Theory)	FISC- 501	75 (56+19)
				Paper-5B (Practical)	FISC- 501(P)	25 (19+6)
		Fish Physiology, Biochemistry and Applies Genetics	Paper -6 100	Paper-6 A (Theory)	FISC- 502	75 (56+19)
				Paper-6B (Practical)	FISC- 502(P)	25 (19+6)
	6th Semester	Advanced Aquaculture	Paper -7 100	Paper-7 A (Theory)	FISC- 601	75 (56+19)
				Paper-7B (Practical)	FISC- 601(P)	25 (19+6)
		Fish Breeding and Hatchery Management	Paper -8 100	Paper-8 A (Theory)	FISC- 602	75 (56+19)
				Paper-8B (Practical)	FISC- 602(P)	25 (19+6)
Total Marks			**800 (32 Credits)**			**800 (32 Credits)**

SEMESTER	PAPER NUMBER	NAME OF THE PAPER	MARKS
Semester - I			
	Paper 1A (Theory)	Fish Biology and Taxonomy	75
	Paper 1B (Practical)	Fish Biology and Taxonomy	25
Semester - II			
	Paper 2A (Theory)	Aquatic Ecology	75
	Paper 2B (Practical)	Aquatic Ecology	25
Third Semester			
	Paper 3A (Theory)	Capture Fisheries	75
	Paper 3B (Practical)	Capture Fisheries	25
Fourth Semester			
	Paper 4A (Theory)	Aquaculture	75
	Paper 4B (practical)	Aquaculture	25
Fifth Semester			
	Paper 5A (Theory)	Fishery Technology, Pathology and Extension education	75
	Paper 5B (Practical)	Fishery Technology, Pathology and Extension education	25
	Paper 6A (Theory)	Fish Physiology, Biochemistry and Applied Genetics	75
	Paper 6B (Practical)	Fish Physiology, Biochemistry and Applied Genetics	25
Sixth Semester			
	Paper 7A (Theory)	Advanced Aquaculture	75
	Paper 7B (practical)	Advanced Aquaculture	25
	Paper 8A (Theory)	Fish Breeding, Hatchery Management	75
	Paper 8B (Practical)	Fish Breeding, Hatchery Management	25

1st Semester B. Sc. (Honours) Paper 1A (Theory) Full marks: 75

Fish Biology and Taxonomy

Unit 1: Taxonomy and Classification:

Taxonomy, Systematics, Species and Species Concept. Classification of fishes (Fin fish and shellfish). Affinities and evolution of fishes. Importance of fishery science.

Unit 2: Body Forms, Fins and Locomotion:

External morphology: Diversity of body forms and compensation factors. Fins: types, structural modifications, origin and evolution of paired fins. Locomotion with special reference to muscles and fins. Non-swimming locomotion.

Unit 3: Fish Anatomy:

Structure and function of digestive system, gills, accessory respiratory organs, air bladder, heart, kidney and skin. Types of scales. Types of pigments and significance of colouration. Basic concepts of skeletal system.

Unit 4: Nervous System and Sense Organs:

Central, peripheral and autonomic nervous system. Cutaneous senses: Touch, taste, temperature and salinity. Sense of smell, hearing and sight. Lateral line and neuromast organs.

Unit 5: Poison Gland, Electric Organ, Bioluminescence:

Poison gland and their significance. Ichthyoacanthotoxism and Ichthyosarcotoxism. Bioluminescence: photophores (Structure and function), significance. Electric organs: Structure, origin, mechanism of electric discharge and significance.

Suggested Reading:

1. Biswas K. P. (2011). Marine prawns and shrimps. Daya Publishing House, New Delhi-35
2. Day Francis. (2007). The fishes of India, Vol 1 & 2. Jagmander Book Agency, New Delhi.
3. Dholakia, A. D. (2010). Identification of prawns/shrimps and their culture. Daya Publishing House, New Delhi-35
4. Dholakia, A. D. (2011). Identification of marine and fresh water mollusc shells. Daya Publishing House, New Delhi-35.
5. Jayram, K. C. (2002). The fresh water fishes of India, A hand book. Zoological Survey of India.
6. Jyoti Sharma (2006). Fishes: Aid to collection and identification. Daya Publishing House, New Delhi-35.
7. Kar. Devashish(2013) Essentials of Fish Biology, dominant publishers and distributors(p) Ltd, Delhi-110053
8. Kar.Devashish (2012).Taxonomy,APH Publishing Corporation, Ansari Road,Darya Ganj, New Delhi-110002.
9. Khanna. S. S. & Singh. H. R. (2005). A Textbook of Fish Biology and Fisheries, Narendra Publishing House, Delhi-6.
10. Lagler, K. F. (1981). Fresh Water Fishery Biology. (2nd edition). W. M. C. Brown Company Publishers, Dubugur, IOWA.
11. Norman, J. R. (2002). A history of fishes: a complete known account of fishes. Asiatic publishing house, Delhi.
12. Parihar, R. P. (2004). A Text book of Fish Biology and Indian Fisheries. Central Publishing House, Allahabad
13. Sandhu, G. S. (2005). A Text book of Fish and Fisheries. Daya Publishing House, New Delhi-35.
14. Yadav, B. N. (2002). Fish and Fisheries, 2nd revised and enlarged edn. Daya Publishing House, Delhi – 35.

1st Semester B. Sc. (Honours) Paper 1B (Practical) Full marks: 25

Fish Biology and Taxonomy

1. Identification and classification of fresh water fish.
2. Identification and classification of fresh water prawn and mollusc.
3. Analysis of morphometric and meristic counts in fish population.
4. Dissection: gill, accessory respiratory organ, digestive system, Weberian ossicle, air bladder, and afferent branchial vessels in commonly available fish.
5. Study of different types of scales and age determination of fishes.

DISTRIBUTION OF MARKS: **Time: 4 hours**

1.	Classification and Identification	6
2.	Morphometric and Meristic counts	6
3.	Dissection/ Scale preparation	5
4.	Viva voce	5
5.	Laboratory records	3
		Total: 25

2nd Semester B. Sc. (Honours) Paper 2A (Theory) Full marks: 75

Aquatic Ecology

Unit 1: Aquatic Ecosystem:

Global distribution of water and hydrological cycle. Diversity and composition of aquatic ecosystems (fresh water, marine and estuarine). Ecological differences between lentic and lotic environments. Adaptations of benthic communities in lotic systems.

Unit 2: Physico–Chemical Characteristics of Water:

Temperature, thermal stratification and overturn, light, salinity, tides, currents, pH, dissolved oxygen, free carbon dioxide, hardness, alkalinity, conductivity, suspended and dissolved solids. Biogeochemical cycles: carbon, phosphorus, nitrogen and sulphur.

Unit 3: Trophic Dynamics - I:

Food chains, energy flow and trophic relationship in lentic and lotic biotopes. Biological Productivity: Basic concepts, methods of estimation of primary productivity and secondary productivity.

Unit 4: Trophic Dynamics - II:

Eutrophication: Causative factors, consequences and control. Physico-chemical and biological differences between oligotrophic and eutrophic water bodies. Ecological succession.

Unit 5: Aquatic Pollution:

Aquatic pollution and its types (biological, chemical, thermal and industrial). Impact of water pollution on aquatic communities and its control measures. Bio-indicator species. Concepts of bio-monitoring with special reference to aquatic biota.

Suggested Readings:

1. Alex, M. & Theresa, A. (1998). Environmental Management of Aquaculture (Fish edition), Chapman & Hall, London.
2. Basheer, A. (1989). Marine Biology: Some Aspects of Marine Ecology and Marine Fisheries. DayaPublishing House, Delhi – 35.
3. Boyd, C. E. & Tucker, C. S. (1998). Pond Aquaculture Water Quality Management. Kluwer Academic Publishers.
4. Das.B and Kar. Devashish (2012). Basic Limnology and Fish Biodiversity, Manglam publishers and Distributors, Delhi-110053
5. Kar. Devashish;(2007). Fundamentals of Limnology and Aquaculture Biotechnology, Daya Publishing House, Delhi- 110035.
6. Kosygin, L (2009). Wetlands of North east India. Akansha publishing house, New Delhi
7. Kumar Arvind. (2008). Aquatic environment and toxicology. Daya Publishing House, Delhi – 35
8. Sakhare, V. B. (2007). Reservoir Fisheries and Limnology. Daya Publishing House, Delhi –35.
9. Sakhare, V. B. (2011). Limnology: current perspectives. Daya Publishing House, Delhi –35
10. Santhanam R, Velayatham&J egathersan P.G. (1990). A Mannual of Fresh Water Ecology. Daya
    Publishing House, Delhi – 35.
11. Schowerbel, J. & Hemmings, B. (1991). Hand Book of Limnology. Scientific Publishers, Jodhpur.
12. Vijaykumar K. & vasanthkumar, B. (2010). Aquatic ecosystem and its management. Daya Publishing House, Delhi – 35.
13. Welcomme, R. L. (2007). Inland Fisheries: Ecology and Management/FAO. Daya Publishing House, Delhi – 110 035.

2nd Semester B. Sc. (Honours) Paper 2B (Practical) Full marks: 25

Aquatic Ecology

1. Qualitative analysis of plankton in different water bodies.
2. Quantitative analysis of plankton in different water bodies.
3. Analysis of physical parameters of water (temperature, velocity, transparency, suspended and dissolved solids).
4. Analysis of chemical parameters of water (pH, dissolved oxygen, free Co_2, alkalinity, hardness, and conductivity).
5. Estimation of primary productivity by light and dark bottle method.

DISTRIBUTION OF MARKS: **Time: 4 hours**

1. Qualitative/quantitative analysis of plankton	6
2. Analysis of physical and chemical parameter	6
3. Primary productivity	5
4. Viva voce	5
5. Laboratory records	3
	Total: 25

3rd Semester B. Sc. (Honours) Paper 3A (Theory) Full marks: 75

Capture Fisheries

Unit 1. Reverine and Coldwater Fisheries:

Types and characteristics of capture fisheries. Riverine capture fisheries: Fisheries of the major Indian rivers. Present status, scope and importance of riverine fisheries in India. Important cold water fish fauna of India, their seed resources, and exploitation. Trout, Mahseer and other game fishes. Status and scope of cold water fisheries with special reference to N. E. India.

Unit 2: Wetland Fisheries:

Ecological features of wetlands and fish diversity. Development, problems and prospects of wetland fisheries in India. Characteristics of *beels* with special reference to N. E. India. Scope and importance of wetland fisheries.

Unit 3: Lacustrine and Reservoir Fisheries:

Difference between lakes and reservoirs. Fisheries of major lakes and reservoirs of India. Impact of dam construction on fish fauna. Importance of fish ways for conservation of fishes.

Unit 4: Estuarine and Marine Capture Fisheries:

Estuaries: Types and physico - chemical characteristics. Zonation of marine ecosystem. Exclusive Economic Zone (EEZ) of India. Fishing seasons. Commercially important estuarine and marine fishes.

Unit 5: Population Studies & Statistics:

Fish population: Definition, population dynamics and estimation of population; causes of fluctuations of fish population abundance. Basic ideas about marking and tagging. Statistics: Types of data (Primary and Secondary), measures of central tendency and dispersion. Regression analysis and correlation coefficient.

Suggested Reading:

1. Bal, V (2002). Marine fisheries. Tata McGraw Hill Publishing Company Ltd.
2. Barbhuiya.H.A and Kar.Devashish(2013),Treatise on Mahseer Fishes, dominant publishers and distributors(p) Ltd, Delhi-110053
3. Biswas K. P. (2011). Marine prawns and shrimps. Daya Publishing House, Delhi – 35.
4. Dholakia, A. D. (2004). Fisheries and Aquatic resources of India. Daya Publishing House, Delhi – 35.
5. Ibrahim, P. (1992). Fisheries Development in India. Concept publishing company, Delhi- 35
6. Jhingran, V. G. (2007). Fish and Fisheries of India. Hindustan Publishing Corporation (India), Delhi – 7.
7. Karakandi, R. (2000). Recreational Fisheries Development in India. Daya Publishing House, Delhi – 35.
8. Mishra, S. R. (2006). Inland Fisheries in India: Issues and Concerns. Daya Publishing House, Delhi – 35.
9. Pandey, K. & Shukla, J. P. (2005): Fish and Fisheries. Rastogi publication, Meerut-2..
10. Sehgal, R. L. (1992). Recent Advances in Cold Water Fisheries. Today and Tomorrow Printers & Publishers, New Delhi – 5.
11. Sugunan, V. V. (1997). Reservoir fisheries of India. FAO publications

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3rd Semester B. Sc. (Honours) Paper 3B (Practical) Marks: 25 marks

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Capture Fisheries

1. Identification and classification of brackish water and marine fish.
2. Identification and classification of some important marine prawn and mollusc.
3. Analysis of length-weight relationship and condition factors.
4. RLG value, analysis of gut content and gastro somatic index in fresh water fishes.
5. Field visits to different natural water bodies and survey of fish fauna.

DISTRIBUTION OF MARKS: **Time: 4 hours**

1.	Identification and classification of fish and mollusc.	6
2.	Length-weight relationship/ gut content analysis.	6
3.	Field Report based on field visits.	5
4.	Viva voce.	5
5.	Laboratory records.	3
	Total:	25

4th Semester B. Sc. (Honours) Paper 4A (Theory) Full marks: 75

Aquaculture

Unit 1. Aquaculture:

Difference between culture and capture fisheries. Concepts and history of aquaculture. An overview of global aquaculture and its status in South East Asia. Prospects of aquaculture in North East India.

Unit 2. Aquaculture Practices:

Classification of aquaculture based on salinity (freshwater, brackish water and marine water), temperature (warm water and cold water), species (finfish, shellfish, molluscs and seaweeds) and management intensity (traditional, extensive, semi-intensive and intensive). Farm mechanization.

Unit 3. Polyculture:

Concept of monoculture and polyculture. Composite fish culture: Pond preparation, fertilization, liming, species selection, combination ratio, stocking density, feeding and harvesting. Economics of composite fish culture.

Unit 4. Integrated Fish Farming:

Principle of integrated fish farming and its advantages. Agro-based fish culture (paddy-cum-fish, horticulture-cum-fish), livestock-cum-fish (Pig-cum-fish, duck-cum-fish, poultry-cum-fish). Economics of different types of integrated fish farming.

Unit 5. Fish Farm Management:

Criteria of site selection, soil and water characteristics. Construction of fish farm: Nursery, rearing and stocking ponds. Water quality management: Application of different types of lime and dosage, application of fertilizers (organic and inorganic). Aquatic weeds and their control. Effect of algal bloom, predatory insects, weeds fishes and their control.

Suggested Readings:

1. Ahmed, S. H. (1998). Advance in Fisheries and Fish production. Narendra Publishing House, Allahabad.
2. Chakroff, M. (1982): Freshwater Fish Pond Culture and Management. Scientific Publishers Main Bhawan, Jodhpur.
3. Desilva, S. & Andensan, T. A. (1995). Fish Nutrition in Aquaculture. Chapman & Hall.
4. Jhingran, V. G. (2007). Fish and Fisheries of India. Hindustan Publishing Corporation (India) New Delhi.
5. Kumar, A. & Bandyopadhyay, P. (2008). Aquaculture and Fisheries. Daya Publishing House, Delhi-35..
6. Pandey, N. & Malik, D. S. (2008). Integrated Fish Farming. Daya Publishing House, Delhi- 35.
7. Sharma, U. & Grover, S. P. (1982). An Introduction to Indian Fisheries. Bishensing Mahendrapal Singh, Dehra Dun - 1.
8. Tilak, R. & Sharma, U. (1982). Game Fishes of India and Angling. International Book Distributors, Dehra Dun.
9. Timmernams, J. A. & Khan, H. (1979). Textbook of Fish culture, Breading and Cultivation of fish. Fishing New Book Ltd. England.

4th Semester B. Sc. (Honours) Paper 4B (Practical) Marks: 25 marks

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Aquaculture

1. Estimation and comparison of nitrate, phosphate, chloride and sulphate content from different natural water and farm water bodies.
2. Identification and classification of aquatic macrophytes.
3. Identification and classification of aquatic insects.
4. Analysis of soil from agricultural land/hilly areas/ fish farm (texture, moisture content, pH, conductivity, nitrate and phosphate,)

DISTRIBUTION OF MARKS: **Time: 4 hours**

1.	Estimation of Nutrients	6
2.	Identification & classification of aquatic macrophytes/insects	5
3.	Analysis of soil	6
4.	*Viva – Voce*	5
5.	Laboratory records	3
		Total: 25

5th Semester B. Sc. (Honours) Paper 5A (Theory) Full marks: 75

Fish Technology, Pathology and Extension Education

Unit 1. Fishing Gears and Crafts:

Types of fishing gears and crafts. Mechanized boats and trawlers. Traditional fishing gears and crafts. Design and manufacture of fishing gears.

Unit 2. Post-harvest Technology and By-products:

Quality maintenance in post-harvest technology. Causes of fish spoilage. Types of fish preservation: Short term and long term preservation (freezing, drying, smoking and canning). Fish by-products and value added products.

Unit 3. Microbiology and Pathology:

Concepts of microbiology. Bacteria: Types, shapes, reaction and growth curve. Viruses. Parasitic diseases: Viral, bacterial, fungal, crustaceans, and helminths.. Non-parasitic diseases: Nutritional and intrinsic. Therapeutic measures: Anti-microbial agents (antiseptics and antibiotics). Vaccines for fish diseases.

Unit 4. Fishery Extension Education:

Extension education: Concepts, teaching methods and aids, Participatory Rural Appraisal (PRA), programme planning, adoption and diffusion of technology, communication models and development of leadership.

Unit 5. Fisheries Organizations in India:

Fishery Institutes of India. Objectives of Krishi Vigyan Kendra (KVK), Fish Farmers Development Agency (FFDA), Brackish Water Fish Farmer's Development Agency (BFDA) and Agricultural Technology Management Agency (ATMA). Fishery Cooperative Societies: Role and prospects.

Suggested Readings:

1. Balachandran (2001). Post Harvest Technology of Fish and Fish Products. Daya Publishing House, Delhi-35.
2. Biswas, K. P. (1999). Text Book of Fish, Fisheries and Technology. Narendra Publishing House, Delhi-6.
3. Biswas, K. P. (2004). Industrial Fisheries. Daya Publishing House, Delhi – 35.
4. Cappuccino. 2007.Microbiology, A Laboratory Manual, Pearson Education, Delhi-110092, India
5. Cutting, C. L. (2007). Fish processing and preservation. Agro-Bios, Jodhpur.
6. Egusa, S. (2001). Infectious diseases of fish. Oxon Ian press Pvt. Ltd. New Delhi.
7. Hameed, M. S. (2002). Modern Fishing Gear Technology. Daya Publishing House, Delhi-35.
8. Khuntia, B. K. (2009). Postmortem changes in fish. Daya Publishing House, Delhi-35.
9. Kothari, C. R. (2001). Research Methodology, Methods and Technique. Wishwa Prakashan. 4835/24, Ansari Road, New Delhi-2.
10. Parihar, R. P. (2000). A Text Book of Fish Biology and Indian Fisheries. Central Publishing House, Allahabad.
11. Rao. A. S. (1999). Introduction to Microbiology. Prentice-Hall of India, NewDelhi-110001
12. Robert, R. J. (2006). The pathology of fishes. University of Wisconsin press.
13. S. Baker, J. Nicklin. J, Khan. N and R. Killinng. 2007. Tayler and Francis, Group, Madison Avenue. New York. NY-100/6.
14. Shafi, S. M. (2003). Applied Fishery Science. Vol-1 & 2 Atlantic Pub, New Delhi.
15. Srivastava R. C. (2009). Fish Mycopathology. Today & Tomorrow printers & publishers, New Delhi
16. Winton, A. L. (1998). Fish and Fish Product. AGRO Publication.

5th Semester B. Sc. (Honours) Paper 5B (Practical) Full marks: 25

Fish Technology, Pathology and Extension Education

1. Study of fishing gears and crafts.
2. Whole mount preparation of fish parasites
3. Histology of fish tissues (liver, intestine and gonads).
4. Preparation of bacterial smears and identification of bacterial strains.
5. Preparation of interview schedule/questionnaires for village survey.
6. Visits to fish markets to study fish landing and preservation.

DISTRIBUTION OF MARKS: **Time: 4 hours**

1. Study of Fishing gears and crafts	5
2. Whole mount preparation of fish parasites/Histology of fish tissue	4
3. Preparation of bacterial smears and identification of bacterial strains.	4
4. Preparation of interview schedule/questionnaires and reports on fish market visits	4
5. *Viva voce*	5
6. Laboratory Records	3
Total:	25

Fish Physiology, Biochemistry and Applied Genetics

Unit 1: Biochemistry:

Chemical constituents of fish: Carbohydrates, proteins, lipids, minerals & Vitamins. Enzymes: Nature, classification and regulation. Glycolysis, TCA cycle, and lipid metabolism.

Unit 2. Physiology I:

Physiology of digestion in fish. Gas exchange across the gills, effects of various factors in gas exchange. Osmoregulation in fresh water, brackish water and marine fishes.

Unit 3. Physiology II:

Blood Composition, haemoglobin and circulation. Excretion: ultra filtration, reabsorption, secretion and formation of urine.

Unit 4: Endocrine System:

Structure and function of major endocrine glands in fishes (hypothalamus, pituitary, thyroid, Islets of Langerhans, inter-renal tissue, gastro-intestinal tract, Corpuscles of Stannius, pineal body and gonads)

Unit 4: Applied Genetics:

Introduction to fish genetics**.** Applied genetics: Hybridization, selective breeding, inbreeding depression, genetic drift, concept of genetic engineering, androgenesis, gynogenesis, triploidy, tetraploidy and transgenic fish. Cryopreservation of gamets. Conservation of fish genetic resources: *In situ* and *ex situ*. Concept of live gene bank.

Suggested Readings:

1. Bansal P. B. (2006). Biotechnology and its application in agricultural science. Daya Publishing House, Delhi -35
2. Colin Ratledge and Bjorn Kristiansen. (2006). Basic Biotechnology - 3rd ed
3. Conn & Stumf. (2001) Outline of Biochemistry. Wiley Eastern Ltd
4. Hoar, W. S. & Randal, D. J. (1996). Fish Physiology (Volumes I - XI). Academic Press.
5. Kamler, E. (1992). Early Life History of Fish, an Energetics Approach. Chapman & Hall.
6. Kumar, S. &Tembhre, M. (2006). Anatomy and Physiology of Fishes. Vikash Publishing house Pvt. Ltd. New Delhi – 14.
7. Lagler, K. F. *et.al* (1992). Ichthyology. John Wiley & Sons Inc. New York – 10016.
8. Lehninger, A. (2000). Biochemistry. Academic Press Inc.
9. Parihar, R. P. (1992). A Text Book of Fish Biology and Indian Fisheries. Central Publishing House, Allahabad.
10. Saxena, Amita. (2006). Text book of Biochemistry. Books & pechas, Delhi.
11. Singh H. R. (2008). Animal physiology and related biochemistry. Shobanlal N Chand & Co.

5th Semester B. Sc. (Honours) Paper 6B (Practical) Full marks: 25

Fish, Physiology, Biochemistry and Applied Genetics

1. Estimation of protein and carbohydrates in fish.
2. Estimation of oxygen consumption in fishes.
3. Counting of RBC and WBC in fish blood.
4. Preparation of haemin crystals of fish blood.
5. Estimation of haemoglobin content in fish blood.
6. Preparation of fish chromosomes.

DISTRIBUTION OF MARKS: Time: 4 hours

1.	Estimation of protein/carbohydrates	5
2.	Haemin crystals and haemoglobin content/ Oxygen consumption in fishes.	4
3.	Counting of RBC / WBC	4
4.	Preparation of fish chromosomes	4
5.	Viva voce	5
6.	Laboratory records	3
		Total: 25

6th Semester B. Sc. (Honours) Paper 7A (Theory) Full marks: 75

Advanced Aquaculture

Unit 1. Modern Aquaculture Practices:

Recent advances in aquaculture. Cage and Pen culture; Site selection, design, species selection, stocking density, feeding and management. Raceways. Trout farming: design and management of a trout farm. Rearing of game and larvicidal fishes.

Unit 2. Fish Nutrition:

Natural food of fishes**,** feeding habits and feed conversion ratio. Different types of feed ingredients used in fish culture; nutrition and energetics. Larval and brood-stock nutrition. Artificial balanced feed composition and formulation.

Unit 3. Sewage-fed Fisheries and Air-breathing Fish Culture:

Physico-chemical and biological characteristics of sewage water. Sewage treatment for fish culture. Management of sewage fed fisheries and its scope.

Culturable air-breathing fishes of India. Prospects of air- breathing fish culture.

Unit 4. Brackish Water Aquaculture and Mariculture:

Ecology of brackish water ponds. Culturable species of brackish water fishes and prawns. Construction and management of brackish water farm. Procurement of seed, stocking and scope of brackish water farming. Mariculture: Concepts and prospects, Introduction to prawn, oyster, pearl, clam and seaweed fisheries.

Unit 5. Ornamental and Aquarium Fishes:

Ornamental and aquarium fishes and their economic importance. Ornamental fishes of India with special reference to the North East. Scope of ornamental fish breeding. Role of Marine Product Export Development Authority (MPEDA) and its activies. Aquaria: Setting and management.

Suggested Readings:

1. Billard, R (1994). Carp Biology and Culture. Springer & Praxis Publishing House, U. K.
2. Datta Munshi, J. S. & Hughes, G. M. (1992). Air-breathing Fishes of India. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
3. Jhingran, V. G. (2007). Fish and Fisheries of India. Hindustan Publishing Corporation (India), Delhi – 110 007.
4. Kumar, H. D. (2003). Sustainability and Management of Aquaculture and Fisheries. Daya Publishing House, Delhi –35.
5. Mathew, L. (1997). Introduction to Aquaculture. John Wiley & Sons, Inc
6. Singh, H. R (1999). Cold Water Aquaculture and Fisheries. Narendra Publishing House, Delhi–6.
7. Srivastava, C. B. L. (1992). Fishery Science and Indian Fisheries. Kitab Mahal, Allahabad.
8. Stickney, R. R (1994). Principle of Aquaculture, John Wiley & Sons, Inc.
9. The Macdonald Encyclopedia of aquaria (1972). A handbook of fishes, plants and all creatures for your aquarium.
10. Vass, K. K. *et.al.* eds (2006). River Fisheries in India: Issues and Current Status. Daya Publishing House, Delhi – 35.

6th Semester B. Sc. (Honours) Paper 7B (Practical) Full marks: 25

Advanced Aquaculture

1. Identification of live feed.
2. Identification of ornamental and aquarium fishes.
3. Setting up an aquarium.
4. Identification of fish feed ingredients and formulation and preparation of fish feed by Square Method.
5. Analysis BOD of sewage water.
6. Project.

DISTRIBUTION OF MARKS: **Time: 4 hours**

1.	Identification of ornamental fish/live feed	3
2.	Setting up an Aquarium/ Analysis of BOD of sewage water	4
3.	Identification of fish feed ingredients, feed formulation and preparation	4
4.	Project report	6
5.	Viva voce	5
6.	Laboratory records	3
	Total:	25

6th Semester B. Sc. (Honours) Paper 8A (Theory) Full marks: 75

Fish Breeding and Hatchery Management

Unit 1. Reproduction and Breeding Behaviour:

Reproductive organs: structure and function. Types of reproduction, sexual dimorphism, courtship and spawning behaviour. Parental care. Migration of fishes: Types, causes and significance.

Unit 2. Developmental Biology:

Breeding cycles, fecundity and gonado somatic Index. Maturation of gonads, gametogenesis, fertilization, cleavage, blastulation, gastrulation, hatching and post larval development.

Unit 3. Procurement of Fish Seed:

Procurement and transportation of carp and air-breathing fish seed from natural sources. Advantages and disadvantages of fish seed from natural resources with respect to its quality and quantity.

Unit 4. Induced Breeding of Carps and Air-Breathing Fishes:

Criteria of selection of brood fishes, collection, transportation and rearing of brood fish. Factors affecting induced breeding. Identification of male and female brood fish. Hypophysation technique. Hormones/Chemical use for induced breeding. Importance of Induced breeding. Wet and dry *bundh* methods for induced breeding of carps.

Unit 5. Hatchery Management:

Types of carp hatchery. Design of Eco Hatchery and portable hatchery. Physical and chemical factors affecting induced breeding of carps and cat fishes. Management of brood stock.

SuggestedReading:

1. Atre, P. K. (2008). Fish Genetics and Aquatic Environment. Navyug publishers, New Delhi.
2. Das, P. and Jhingran A. G. (2005). Fish Genetics in India. Today & Tomorrows Printers & Publishers. New Delhi.
3. Ghosh, R. (2007). Fish genetics and endocrinology. Sawstic publishers and distributors, Delhi
4. Jhingran, V. G. (2007). Fish and Fisheries of India. Hindustan Publishing Corporation (India), Delhi – 110 007.
5. Kamler, E. (1992). Early Life History of Fish, an Energetics Approach. Chapman & Hall.
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6th semester B. Sc. (Honours) Paper 8B (Practical) Full marks: 25

Fish Breeding and Hatchery Management

1. Hypophysation technique: Collection of pituitary gland, preparation of extract and demonstration of hypophysation.
2. Study of maturity stages and gonado-somatic index of carps.
3. Determination of Physico-chemical parameters of hatchery water (temperature, dissolved oxygen, pH, alkalinity, free carbon dioxide and turbidity).
4. Designing of Eco- hatchery.
5. Study of post larval development of fish from permanent slide.

DISTRIBUTION OF MARKS: **Time: 4 hours**

1.	Hypophysation techniques/ preparation of extract / Designing of Eco-hatchery	6
2.	Estimation physico chemical parameters of hatchery water / maturity stages and gonado-somatic index	6
3.	Study of Post larval development/	5
4.	Viva voce	5
5.	Laboratory Records	3