GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 8
Subject Name: Aquaculture Technology
Subject Code: 1380412

Prerequisite:
Basic knowledge of biology, fisheries science, and water quality management is required. Understanding aquaculture principles, aquatic species biology, and environmental sustainability will help students explore advanced aquaculture systems, culture techniques, and technological innovations for improving aquaculture productivity and sustainability.

Rationale:
Aquaculture Technology focuses on modern techniques, equipment, and management strategies to enhance fish and shellfish farming efficiency. It equips students with skills in recirculating aquaculture systems, biofloc technology, water treatment, disease prevention, and feed optimization, promoting sustainable and profitable aquaculture practices.

Course Scheme :

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		**Practical**		
L	**T**	**PR**	**C**	ESE (E)	PA(M)	ESE (V)	PA (I)	
4	0	8	8	70	30	30	20	150

Course Content:

Unit No.	Content	No. of Hours	Weightage (%)
1	Importance of coastal aquaculture; Aqua farms; Design and construction; Criteria for selecting cultivable species; Culture systems and management practices – extensive, semi intensive and intensive culture practices. Seed production in controlled condition; Types; Design and management of hatchery – induced spawning; Mass production of seeds; feed formulation; Artificial insemination - *in vitro* fertilization.	12	20
2	Fish Feed Technology: Types of feed, conventional feed vs functional feeds; Principles of feed formulation and manufacturing, diets suitable for application in different aquaculture systems; feed formulation ingredients; Use of natural and synthetic carotenoids; feed additives; Role of additives; Feed processing: Gelatinization, extrusion Technology, pellet dressing with heat liable nutrients; Feed evaluation; Feeding schedule to different aquatic organisms, check tray operation and feed management, Biomass calculation based on feed intake; Post-harvest Biotechnology: Fundamental aspects of freezing, methods of freezing; Delaying of spoilage. Molecular Tools in Conservation of Fisheries Resources: Artificial Hybridization: Heterosis, Control of fish diseases by selection; selective breeding of disease resistant fish.	12	25

3	Culture of Live food organisms: Candidate species of phytoplankton & zooplankton as live food organisms of freshwater & marine species; biology & culture requirements of live food organisms: green algae, diatoms, rotifers and brine shrimp.	12	10
4	Male and female of finfish and shellfish; Primary and secondary sex characters; Process of Oogenesis & Spermatogenesis, metabolic changes during gametogenesis; neuroendocrine system in crustacean & molluscs & its role in control of reproduction; mechanism of hormone synthesis, release, transport & action; Pheromones & reproductive behaviour; environmental factors influencing reproduction; Advances in Fish Breeding: Hypophysation, cryopreservation technique, genetic basis of determination of sex; chromosome manipulation: ploidy induction, sex reversal; gynogenesis and androgenesis; Broodstock management; Application of cross breeding in aquaculture; Selective breeding: qualitative and quantitative traits for selection, methods of selection; Inbreeding and heterosis in various economic characters; hormone induced ovulation; Synthetic hormones for induced breeding- GnRH analogue structure and function.	12	25
5	Bio-floc technology; Aquaponics; Zero water exchange aquaculture system; Aqua mimicry; Hydroponics; Raceway system of aquaculture; Bioremediation in Aquaculture systems: Genetically modified organisms in waste water treatment; Bioremediation for soil and water quality improvement; Micro-algae- indoor and mass-culture methods, Biotechnological approaches for production of important microalgae and other commercial important products.	12	20
	Total Hours:	60	100

Textbook:

1. Jhingran, V. G. (1991). Fish and Fisheries of India. Hindustan Publishing Corporation.
2. Pillay, T. V. R., & Kutty, M. N. (2005). Aquaculture: Principles and Practices. Blackwell Publishing.
3. Boyd, C. E. (2015). Water Quality: An Introduction. Springer.
4. New, M. B., & Wijkström, U. N. (2002). Use of Fishmeal and Fish Oil in Aquafeeds: Further Thoughts on the Fishmeal Trap. FAO Fisheries Circular.
5. Lavens, P., & Sorgeloos, P. (1996). Manual on the Production and Use of Live Food for Aquaculture. FAO Fisheries Technical Paper.

Reference Books:

1. Stickney, R. R. (2009). Aquaculture: An Introductory Text. Cambridge University Press.
2. Webster, C. D., & Lim, C. (2002). Nutrient Requirements and Feeding of Finfish for Aquaculture. CABI Publishing.

3. FAO (2011). Aquaculture Development: FAO Technical Guidelines for Responsible Fisheries.
4. Gupta, S. K., & Gupta, P. C. (2006). General and Applied Ichthyology (Fish and Fisheries). S. Chand Publishing.
5. De Silva, S. S., & Anderson, T. A. (1995). Fish Nutrition in Aquaculture. Springer.
6. Se-kwon Kim , (2015) Handbook of Marine Biotechnology, Springer
7. Felix,S,(2010) Handbook of Marine and Aquaculture Biotechnology AGROBIOS INDIA
8. Ramchandran, V, Aquaculture Biotechnology, Black Prints
9. Gautam, N,C, (2007) Aquaculture Biotechnology, Shree Publishers and Distributors

Course Outcomes:

No.	Course Outcomes	RBT Level*
1	Describe the principles and advancements in aquaculture technology, including system designs and management.	RM, UN
2	Explain the role of biofloc, recirculating aquaculture systems (RAS), and other innovative techniques in sustainable aquaculture.	UN, AP
3	Analyze water quality management, disease control measures, and feed optimization strategies in aquaculture systems.	AN, EL
4	Evaluate the efficiency and environmental impact of different aquaculture technologies and their applications.	EL, CR
5	Apply technological advancements to improve aquaculture production, resource utilization, and sustainability.	AP, CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

1. Demonstration of extensive, semi-intensive, and intensive aquaculture systems.
2. Site selection criteria for aqua farms and hatcheries.
3. Measurement of pH, dissolved oxygen, ammonia, nitrate, and salinity in aquaculture water.
4. Water sampling techniques and aeration methods.
5. Formulation of fish feed using locally available ingredients.
6. Preparation of artificial diets and pelletization.
7. Evaluation of feed efficiency and feed conversion ratio (FCR).
8. Culture of phytoplankton (green algae, diatoms) and zooplankton (rotifers, brine shrimp).
9. Microscopic identification of live feed organisms.
10. Induced breeding using synthetic hormones (GnRH analogs).
11. Identification of primary and secondary sexual characteristics in fish and shellfish.
12. Collection and microscopic observation of fish gametes (oocytes and sperms).
13. Demonstration of fish freezing techniques and spoilage prevention methods.
14. Quality assessment of stored and processed fish products.
15. Demonstration of biofloc technology in aquaculture.
16. Application of probiotics and biofilters in maintaining water quality.
17. Small-scale aquaponics and hydroponics setup.

List of Laboratory/Learning Resources Required

1. Equipment & Instruments
   - Water Quality Analysis Tools: pH meter, dissolved oxygen meter, ammonia/nitrate test kits.
   - Microscopes: Compound and stereo microscopes for feed and gamete observation.
   - Incubators & Aeration Systems: For hatchery and live feed culture.
   - Extruder & Pelletizer: For fish feed preparation.
   - Cryopreservation Equipment: For gamete and embryo storage.
   - Freezers & Cold Storage Units: For post-harvest technology studies.
   - Biofloc & Aquaponics Units: For sustainable aquaculture demonstrations.
2. Field Sampling & Collection Tools
   - Water Sampling Bottles & Plankton Nets: For field assessments.
   - Sediment Samplers & Sieves: For soil quality analysis.
   - Hand Nets & Breeding Trays: For hatchery and breeding practices.

   3. Glassware & Consumables
   - Beakers, flasks, burettes, pipettes, and measuring cylinders.
   - Filtration units, filter papers, and staining reagents.
   - Nutrients and culture media for live feed production.
4. Reference Manuals & Learning Resources
   - FAO Guidelines on Responsible Aquaculture & Fisheries Management.
   - Fish and Shellfish Nutrition (Hardy & Tacon, 2002).
   - Manual on Live Feed Culture for Aquaculture (Lavens & Sorgeloos, 1996).
   - Fish Reproductive Physiology and Hatchery Techniques (FAO Technical Papers).

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