COURSE STRUCTURE AND SYLLABI

of

Bachelor of Fishery Science
(B.F.Sc.)
(2021- 2025 Batch)

Centurion UNIVERSITY

Shaping Lives… Empowering Communities…

SCHOOL OF FISHERIES

CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT

Odisha-761211, INDIA

Web Site: - www.cutm.ac.in

B.F.Sc. Degree Programme

SCHOOL OF FISHERIES

Centurion University of Technology and Management

Course structure

First Semester

Course No	Course title	Credits
FSAQ 1101	Principles of Aquaculture	2(1+1)
FSRM 1101	Taxonomy of Finfish	3(1+2)
FSRM1102	Taxonomy of Shellfish	2(1+1)
FSEM 1101	Meteorology, Climatology and Geography	2(1+1)
FSEE 1101	Statistical Methods	3(2+1)
FSAQ 1112	Fundamentals of Biochemistry	3(2+1)
FSHM 1107	Fundamentals of Microbiology	3(2+1)
FSEM 1102	Soil and Water Chemistry	3(2+1)
FSPT 1101	Fish in Nutrition	1(1+0)
FSCC 1101	Swimming **CNC***	1(0+1)
	Total	**22(13+9)**

*CNC= Compulsory non-credit course.

Second Semester

Course No	Course title	Credits
FSAQ 1202	Fresh Water Aquaculture	3 (2+1)
FSRM 1203	Anatomy and Biology of Finfish	3(2+1)
FSEM 1203	Limnology	3(2+1)
FSEM 1205	Marine Biology	3(2+1)
FSRM 1206	Inland Fisheries	3(2+1)
FSPT 1202	Food Chemistry	3(2+1)
FSEE 1206	Information and Communication Technology	2(1+1)
FSCC 1202	Physical Education, First Aid & Yoga Practices	1(0+1) **CNC***
FSAQ 1207	Aquaculture in Reservoirs	2(1+1)
	Total	**22(14+8)**

*CNC= Compulsory non-credit course.

Third Semester

Course No	Course title	Credits
FSRM 2105	Physiology of Finfish and Shellfish	3(2+1)
FSAQ2109	Fish Food Organisms	2(1+1)
FSEM2106	Aquatic Ecology, Biodiversity and Disaster Management	3(2+1)
FSEM 2104	Fishery Oceanography	2(1+1)
FSAQ 2103	Ornamental Fish Production and Management	2(1+1)
FSPT2103	Freezing Technology	2(1+1)
FSAQ 2111	Genetics and Breeding	2(1+1)
FSHM 2106	Fish Immunology	2(1+1)
FSEE 2102	Fisheries Economics	3(2+1)
FSRM 2109	Aquatic Mammals, Reptiles and Amphibians	1(1+0)
	Total	**22(13+9)**

Forth Semester

Course No	Course title	Credits
FSAQ 2204	Coastal Aquaculture and Mariculture	3(2+1)
FSHM 2204	Therapeutics in Aquaculture	2(1+1)
FSAQ 2208	Fish Nutrition and Feed Technology	3(2+1)
FSPT 2204	Fish Canning Technology	2(1+1)
FSPT 2205	Fish Packaging Technology	2(1+1)
FSHM 2201	Fish and Shellfish Pathology	3(2+1)
FSFE 2203	Fishing Craft Technology	2(1+1)
FSEE 2207	Fisheries Extension Education	2(1+1)
FSAQ 2206	Shellfish Hatchery Management	2(1+1)
FSEE 2208	Communication Skills and Personality Development	1(0+1)
	Elective Course	3 credit
	Total	**22(12+10) +3**

Fifth Semester

Course No	Course title	Credits
FSAQ 3105	Finfish Hatchery management	3(2+1)
FSRM 3104	Anatomy and biology of shell fish	2(1+1)
FSHM 3103	Pharmacology	3(2+1)
FSHM 3105	Fish Toxicology	2(1+1)
FSRM 3107	Marine Fisheries	3(2+1)
FSEE 3104	Fisheries Cooperative and Marketing	2(1+1)
FSFE 3105	Fishing Gear Technology	2(1+1)
FSRM 3108	Fish Population dynamics and Stock Assessment	3(2+1)
FSEM 3108	Coastal Zone Management	2(1+1)
FSHM 2202	Microbial and Parasitic Diseases of Fish and Shellfish	3(2+1)
FSPT 3209	Quality assurance of Fish and Fishery Products	3(2+1)
	Elective Course	3 credit
	Total	**28(17+11) +3**

Sixth Semester

Course No	Course title	Credits
FSAQ 3210	Introduction to biotechnology and Bioinformatics	2(1+1)
FSFE 3202	Refrigeration and Equipment Engineering	3(2+1)
FSEE 3203	Fisheries Policy and Law	1(1+0)
FSEM 3207	Aquatic Pollution	2(1+1)
FSFE 3206	Fishing Technology	2(1+1)
FSPT 3206	Fish Production and Value Addition	3(2+1)
FSPT 3208	Microbiology of Fish and Fisheries Product	3(2+1)
FSFE 3204	Navigation and seamanship	2(1+1)
FSPT 3207	Fish Byproducts and waste utilization	2(1+1)
FSEE 3205	Fisheries Business management and Entrepreneurship development	1(1+0)
FSFE 2101	Aquaculture Engineering	**3(2+1)**
	Elective Course	3 credit
	Total	**24(15+9)+3**

Seventh Semester

Sl. No.	Course Title	Course Number	Credit hour
	Student READY Programme (Experiential Learning)	**FSEL 4101**	
1	Experiential Learning modules (any one)		
	Fish seed Production **(or)**		20(0+20)
	Post Harvest Technology		20(0+20)
	Total		**20(0+20)**

Eighth Semester

Sl. No.	Course Title	Course Number	Credit hour
	Student READY Programme (In-plant attachment)		
1	In-plant attachment (any one)	**FSRW 4201**	10 (0+10)
	Domain Based Subjects		
2	Rural Fisheries Work Experience (FFWE)	**FSRW 4201**	10 (0+10)
	Total		**20 (0+20)**

Domain courses for B.F.Sc

Sl.No	Domain	Credit	T+P+P
1	Organic Farming	**29**	3+15+11
2	Intensive Aquaculture	**29**	3+15+11
3	Seed Production using Manual and Molecular Methods	**29**	3+15+11
4	Genetic Engineering & Genomics	**29**	3+15+11
5	Nutraceuticals	**29**	3+9+17
6	SMART Agriculture	**29**	3+15+11
7	Protected Horticulture	**29**	3+15+11
8	Food Processing	**29**	3+15+11
9	Agri Business Management	**23**	2+0+21
10	Commodity and Food Storage	**29**	3+15+11
11	Dairy Processing and Development	**28**	3+15+10
12	Smart Farm Machinery	**28**	6+9+13
13	Soil and water conservation through watershed	**28**	4+11+13
14	Fish Processing Technology	**25**	3+11+11

Job Readiness (0-3-0)

Course I: IELTS - Reading, Listening, Speaking and Writing

Course II: IELTS Verbal

Course III: Quantitative Aptitude

Course IV: Logical Reasoning

Course I: IELTS - Reading, Listening, Speaking and Writing

Module I: IELTS Reading

- Skimming and Scanning
- Sentence Completion
- Choose the Correct options (A, B, C, D)
- Locating the Specific Information
- Assessment on Reading Skill

Module II: IELTS Listening

- Notes/ Form/Table completion
- Label the Map/Passage, Multiple Choice Questions
- Complete the Sentences, Listening to Find Information
- Assessment on Listening Skills

Module III: IELTS Speaking

- Speaking about yourself, your family, your work and your interests
- Introduction & Interview
- Topic Discussion (e.g., Environment, Covid 19, Job)
- Assessment on Speaking Skills

Module IV: IELTS Writing

- Summarising the chart, table or graph
- Comparing and contrasting graphs and tables
- Describing maps & diagrams
- Agreeing & disagreeing
- Expressing a personal view & opinion
- Assessment on Writing Skill
- CV Writing (2nd year)
- Letter Writing
- Email Writing(2nd year)
- Getting Started –writing an introduction

Course II: IELTS Verbal

Module I: Grammar (4 Hrs.)

- Articles
- Prepositions
- Subject-Verb
- Spotting Errors
- Sentence Correction

Module II: Vocabulary (5 Hrs.)

- Synonyms
- Antonyms
- Contextual Vocabulary

Module III: Reading Comprehension (3 Hrs.)

- Paragraph/ Sentence Completion
- Jumbled Sentences/ Jumbled Paragraph
- Reading Comprehension

Module IV: Verbal Analogies (3 Hrs.)

Course III: Quantitative Aptitude

Module I: Number System & Operation (14 Hrs.)

- Speed Math-1 : Multiplication tricks, Square, cube, square root, Cube root tricks
- Speed Math-2 : Speed Calculations
- Number System-01 : Operation on Numbers, Classification of Numbers, Tests of Divisibility, Unit Digit Calculation
- Number System-02 : Arithmetic Progression, Geometric Progression, Factors & Factorials, Trailing Zeroes, Remainder Theorem
- HCF & LCM : Concepts, short tricks, question discussion
- Average : Concepts, short tricks, question discussion
- Assessments

Module II: Basic Arithmetic (16 Hrs.)

- Percentage-01 : Basics of Percentage, Effective percentage, shortcuts
- Percentage-02 : Advanced questions and discussions
- Profit & Loss-01 : Basics and advanced questions of Profit & Loss and shortcuts
- Profit & Loss-02 : MRP, Discount, Successive discount
- Ratio & Proportion : Types of ratios, Basics & Advanced Question
- Age : Concepts & Shortcuts
- Partnership : Concepts & Shortcuts
- Mixture & Alligation : Rule of Alligation, Basics & Advanced question, Short tricks
- Assessments

Module III: Time & Analysis (17 Hrs.)

- Time, Speed, Distance : Concepts, Problems based on relations, Average speed, Stoppage time
- Trains : Relative Speed & All types of train problems
- Boats & Streams : Basics, Upstream, Downstream & Shortcuts
- Race : All concepts & Shortcuts
- Time & Work : Efficiency, wages, alternative day, chain rule
- Pipes & Cistern : Positive & Negative work
- Simple Interest : Concepts & Shortcuts on Simple Interest & Instalments
- Compound Interest : Concepts & Shortcuts on Simple Interest & Instalments
- Logarithm : All Formulae, concepts & Shortcuts
- Assessments

Module IV: Advanced Arithmetic (16 Hrs.)

- Equation : Linear & Quadratic

- Permutation : All concepts & Shortcuts on factorial, fundamental principles of counting
- Combination : All concepts & Shortcuts on Selection (Groups/teams)
- Probability: Terms related to Probability, Event, Theorems related Probability, Conditional Probability. Shortcuts on coins, dices, balls, cards, etc
- Data Interpretation : (Bar/Pi-Chart /Line) graph
- Mensuration : Area & Volume
- Height & Distance : Lines of Sight, Horizontal line, Angle of Elevation, Angle of Depression
- Assessments

Course IV: Logical Reasoning

Module I: Verbal Reasoning-I (14 Hrs.)

- Series-1 : Number series (Missing & Wrong)
- Series-2 : Letter, Alpha numeric, Miscellaneous series
- Coding & Decoding : Letter Coding, Number coding, Message coding, Substitution coding, Conditional coding
- Word Problem : Analogy, Odd man out, word formation, letter pair
- Logical Thinking : Brain Riddles
- Assessments

Module II: Verbal Reasoning-II (14 Hrs.)

- Order & Ranking : Ranking & Sequence
- Direction Sense Test : Shortest Distance, Angular movement concept and Dusk & Dawn
- Clock : Concepts of Angle, Reflex angle, Right angle Opposite, Coincide and Incorrect clock
- Calendar : All concepts & Shortcuts
- Blood Relation : Jumbled-up descriptions, coded relations, Relation Puzzles
- Assessments

Module III: Non Verbal Reasoning (14 Hrs.)

- Cubes & Dices
- Cubes & Cuboids
- Embedded Figure& Figure series
- Figure Puzzle & Figure grouping
- Figure Counting
- Mirror & Water Image
- Paper Cutting & Paper folding
- Assessments

Module IV: Advanced Reasoning (16 Hrs.)

- Sitting Arrangement : Circular, Square, Rectangular, Linear, Triangular
- Puzzle : Box, Floor, Month, Day
- Advanced Puzzle : 3 variable
- Logical Venn Diagram
- Syllogism
- Statement & Conclusion
- Data Sufficiency
- Assessments

Track/ Domain courses for B.F.Sc
For VIII semester

Course Code	Name of the Domain	Credits	T-P-P
	Organic Farming	**29**	3+15+11
CUOF2230	Organic Farming	3	1+2+0
CUOF2231	Certification and Inspection Systems in Organic Farming in India	3	1+2+0
CUOF2232	Biopesticides and Biofertilizers	3	1+2+0
CUOF2233	Organic Production- Field Crops	3	0+3+0
CUOF2234	Organic Production- Horticultural Crops	3	0+3+0
CUOF2235	Biofertilizer and Biopesticide Production Technology	3	0+3+0
CUOF2236	AELP Project	11	0+0+11
	Dairy Processing and Development	**28**	3+15+10
CUDP2240	Milk Processing in Dairy Industry	3	1+2+0
CUDP2241	Dairy Starters in Fermented Milk Products	3	1+2+0
CUDP2242	Quality Assurance in Dairy Industry	3	1+2+0
CUDP2243	Dairy Products Development	3	0+3+0
CUDP2244	Synbiotic Dairy Foods	3	0+3+0
CUDP2245	Quality Analysis of Milk and Milk Products	3	0+3+0
CUDP2246	Project/Industrial internship	10	0+0+10
	Intensive Aquaculture	**29**	3+15+11
CUAQ2250	Intensive Fish Rearing	3	1+2+0
CUAQ2251	Ornamental Fish Farming	3	1+2+0
CUAQ2252	Biofloc Aquaculture	3	1+2+0

CUAQ2253	Framing of SOPs for Intensive fish culture and ornamental fish culture	3	0+3+0
CUAQ2254	Health Management in Aquaculture	3	0+3+0
CUAQ2255	Feed Management in Aquaculture	3	0+3+0
CUAQ2256	Aquaculture rearing	11	0+0+11
	Seed Production using Manual and Molecular Methods	**29**	3+15+11
CUSP2260	Breeding methods: conventional and molecular approach	3	1+2+0
CUSP2261	Seed production of vegetable and cereals crops	3	1+2+0
CUSP2262	Seed certification	3	1+2+0
CUSP2263	Hybridization techniques	3	0+3+0
CUSP2264	Vegetable Seed production	3	0+3+0
CUSP2265	Cultivar purity and seed quality testing	3	0+3+0
CUSP2266	AELP Project	11	0+0+11
	Genetic Engineering & Genomics	**29**	3+15+11
CUGE2270	Computational Biology	3	1+2+0
CUGE2271	Genetic Engineering and its applications	3	1+2+0
CUGE2272	Plant Molecular Biology	3	1+2+0
CUGE2273	Molecular Genomics	3	0+3+0
CUGE2274	Plant Tissue Culture Technologies	3	0+3+0
CUGE2275	Techniques in Molecular Biology	3	0+3+0
CUGE2276	AELP Project	11	0+0+11
	Nutraceuticals	**29**	3+9+17
CUNU2280	Introduction to Nutraceutical	3	1+2+0
CUNU2281	Functional Food	3	1+2+0
CUNU2282	Nutrigenetics	3	1+2+0
CUNU2283	Development of Personalized Food and Medicine	3	0+1+2
CUNU2284	Development of Biopesticides and Biofertilizers	3	0+1+2
CUNU2285	Development of Immune Boosters	3	0+1+2
CUNU2286	AELP Project	11	0+0+11
	SMART Agriculture	**29**	3+15+11
CUAG2290	Applied hi-tech horticulture	3	1+2+0
CUAG2291	Protected cultivation of vegetable crops	3	1+2+0
CUAG2292	High-tech fruit culture	3	1+2+0
CUAG2293	Management of high-value cut-flowers	3	0+3+0
CUAG2294	Management of crops in hydroponics	3	0+3+0
CUAG2295	Use of smart tools for precision crop management	3	0+3+0

CUAG2296	AELP Project/Industrial internship	11	0+0+11
	Protected Horticulture	**29**	3+15+11
CUPH2300	Applied hi-tech horticulture	3	1+2+0
CUPH2301	Protected cultivation of vegetable crops	3	1+2+0
CUPH2302	High tech fruit culture	3	1+2+0
CUPH2303	Production technology of cut flowers & loose flowers	3	0+3+0
CUPH2304	Protected floriculture	3	0+3+0
CUPH2305	Production management of medicinal and aromatic crops	3	0+3+0
CUPH2306	AELP Project	11	0+0+11
	Food Processing	**29**	3+15+11
CUFP2310	Processing Technology of Cereals and Millets	3	1+2+0
CUFP2311	Processing Technology of Legumes and Oilseeds	3	1+2+0
CUFP2312	Processing Technology of Fruits, Vegetables, Spices and Condiments	3	1+2+0
CUFP2313	Product Development and Packaging Technologies	3	0+3+0
CUFP2314	Food Standards and Regulations and HACCP Systems	3	0+3+0
CUFP2315	Sensory Evaluation and Nutritional Labelling of Foods	3	0+3+0
CUFP2316	AELP Project/Industrial internship	11	0+0+11
	Agri Business Management	**23**	2+0+21
CUAB2320	Agri Food Markets and Value Chain Analysis	3	1+0+2
CUAB2321	Agri Input Marketing	3	1+0+2
CUAB2322	Rural Haat and Market Analysis	2	0+0+2
CUAB2323	Community Owned and Managed Agri Businesses	2	0+0+2
CUAB2324	Agri Warehouse Management	2	0+0+2
CUAB2325	Sales and Distribution of Agrifood Products (Internship at LMDC)	11	0+0+11
	Commodity and Food Storage	**29**	3+15+11
CUFS2330	Storage Entomology	3	1+2+0
CUFS2331	Seed pathology	3	1+2+0
CUFS2332	Post-harvest biochemistry and physiology of crops	3	1+2+0
CUFS2333	Recent trends in post-harvest technology	3	0+3+0
CUFS2334	Pest management techniques in storage	3	0+3+0
CUFS2335	Post-harvest storage of fruits and vegetables	3	0+3+0
CUFS2336	AELP Project	11	0+0+11

	Fish Processing Technology	25	3+11+11
CUFT 2305	Post harvest handling and processing of fish and shellfish	2	1+1+0
CUFT 2351	Design, maintenance of fish processing plant and instrumentation	2	1+1+0
CUFT 2352	Quality assurance, management and certification	1	1+0+0
CUFT 2353	Fish and shellfish waste management	3	0+3+0
CUFT 2354	Microbiological analysis of fish and fisheries products	3	0+3+0
CUFT 2355	Biochemical analysis of fish and fisheries product	3	0+3+0
CUFT 2356	Preparation of different fisheries products and quality assessment	11	0+0+11

As per V Dean's committee suggestion, the AELP modules were developed in the track mode where a student will learn in one subject and develop expertise.

Evaluation for track I as that of practical courses mode.

Evaluation of Experiential Learning Programme

Sl no.	Parameter	Max marks
1	Project Planning and Writing	10
2	Presentation	10
3	Regularity	10
4	Monthly Assessment	10
5	Output delivery	10
6	Technical Skill Development	10
7	Entrepreneurship Skills	10
8	Business networking skills	10
9	Report Writing Skills	10
10	Final Presentation	10
	Total	100

Objectives of the course

Bachelor of Fishery Science is an under graduate, it is the science that involved in managing of catching processing, marketing and conservation of fish. The course studies habits and habitats breeding of various species of fish. It involves farming and husbandry of important fishes and aquatic organisms in fresh water, brackish water and marine environment. It also deal with the improvement of fishermen's community and also recognize protect and enhance the role of fisherwomen in the fisheries economy.

The main objectives of this course are to provide quality education for the production of professionally qualified and technically skilled man power to the fishery sector of the county, to undertake Fisheries Research Extension for the sustained growth of fisheries, to find out solutions to the problems encountered by the aqua farmers, fisher folk and entrepreneurs for alienating poverty and ascertaining nutritional security of the country and to achieve overall development of the fisheries sector.

Learning Course Outcomes

1. To know the basis of technologies of fisheries and aquaculture, to understand the principles of its importance, purpose and application.

2. To know the conditions of development of aquatic organisms and its habitat conditions, formation and change patterns of yielding in relate with the environmental changes of anthropogenic influence.

3. To know the fisheries and aquaculture schemes used in breeding, rearing and feeding technologies in farms, their purpose and principles of application, be aware of the fisheries and aquaculture design and construction principles, taking into account the legislation and directives.

4. Describe the fisheries and aquaculture business management features, methods, and strategies for aquaculture business development, operational funding, fisheries and aquaculture production innovation and marketing issues and strategies.

5. Apply traditional research methods, scientific literature, information technologies and statistical methods of calculation to perform and summarize the research and creative use results of analysis by preparation of the final thesis and oral presentations.

6. Apply modern equipment in laboratories, special computer programs for design of fisheries and aquaculture farms by implementation of innovative ideas for management of farms.

7. Describe the fisheries and aquaculture technological processes, identify problems and solve them, relate agriculture activity and aquaculture productivity and safety, analyze and evaluate effects of the fisheries and aquaculture on the environment, to provide the preventive safety measures.

8. Apply methods and techniques used in fisheries and aquaculture design and construction, their management methods and quality assurance principles.

9. Solve the technological challenges related to management of fisheries and aquaculture farms; organize activities to ensure their entrepreneurship and competitiveness.

10. To critically and logically contemplate, to have a reasoned opinion and be able to defend it, to gather and present scientific information to different audience

Course Outcome of the course

Upon successful completion of the B.Sc. programme graduates will be qualified to work as Fisheries Development Officers in the State Governments. Work as Technical/Specialist/Market Recovery Officers in banks, Officers in Insurances Companies. Technical officers in States/Central Fishery Institutions, Post graduate with Ph.D. are eligible for Scientist/Assistant Professor in Central/State Organizations and Universities.

This course offers great scope to the students for self- employment in establishing Farms/Hatcheries/Processing plants and Fish export business. The BFSc graduates have very good career opportunities in the field as it is less saturated as compared to other fields, and there is huge scope to develop fisheries in our county.

SEMESTER – I

1. Principles of Aquaculture [FSAQ 1101] 2(1+1)

Objective: Principles of Aquaculture gives outline about the basics and history of aquaculture. A wide range of aspects such as Systems of aquaculture, aquaculture in different types of water bodies, Principles of organic aquaculture, Pond management, study of Monoculture, polyculture and integrated culture systems, Water and soil quality in relation to fish production and estimation of productivity, factors affecting productivity of ponds, Nutrition, health management and economics were portray detailed.

Course Outcome: Students will develop a better understanding of the history of aquaculture and different production systems employed for better production

Theory

Basics of aquaculture, definition and scope. History of aquaculture: Present global andnational scenario. Aquaculture vs Agriculture. Systems of aquaculture - pond culture, pen culture,cage culture, running water culture and zero water exchange system,. Extensive, semi-intensive,intensive and super intensive aquaculture in different types of water bodies viz., freshwater,brackish water inland saline and marine water. Principles of organic aquaculture.Pre-stockingand post stocking pond management. Carrying capacity of pond, factors influencing carryingcapacity. Criteria for selection of candidate species for aquaculture. Major candidate species foraquaculture: freshwater, brackish-water and marine. Monoculture, polyculture and integratedculture systems. Water and soil quality in relation to fish production.Physical, chemical andbiological factors affecting productivity of ponds.

Practical

Aquaculture production statistics- world and India.Aquaculture resources of world andIndia.Components of Aquaculture farms.Estimation of carrying capacity.Practices on prestockingand post stocking management. Growth studies in aquaculture system. Study on wasteaccumulation in aquaculture system (NH3, Organic matter, CO2). Analysis of manure.

References

1. Aquaculture principles and practices ----TVR Pillay and MN Kutty
2. Encyclopedia of aquaculture ----RR Stickney
3. Hand book fisheries and aquaculture----ICAR New Delhi 2006
4. Sustainable aquaculture ---- BB Jena and Carl D.Webster
5. Hand book of fisheries and aquaculture ---- NIR Board of Consultants (Asia Pacific press)

2. Taxonomy of Finfish [FSRM 1101] 3(1+2)

Objective: To enable the students in differentiating genera/ species up to stock level using classical and molecular techniques. To enable the student to identify and differentiate the fin fish easily

Course Outcome: Students will be able to identify commercially important fin fish which are available in Indian coast

Theory

Principles of taxonomy. Nomenclature, types. Classification and interrelationships.Criteriafor generic and specific identification.Morphological, morphometric and meristic characteristicsof taxonomic significance.Major taxa of inland and marine fishes up to family level.Commerciallyimportant freshwater and marine fishes of India and their morphological characteristics.Introduction to modern taxonomic tools: karyotaxonomy, DNA barcoding, protein analysis andDNA polymorphism.

Practical

Collection and identification of commercially important inland and marine fishes.Study oftheir external morphology and diagnostic features.Modern taxonomic tools - Protein analysisand electrophoretic studies; Karyotaxonomy - chromosome preparation and identification.DNAbarcoding, DNA polymorphism; Visit to fish landing centres to study commercially importantfishes and catch composition.

3. Taxonomy of Shellfish [FSRM 1102] 2(1+1)

Objective:

This course deals with the classification and identification of commercially important crustaceans and molluscs occurring in Indian waters. The systematic zoology is the science that discovers names, determines relationships, classifies and studies the evolution of living organisms

Taxonomical study reveals numerous interesting phenomena in shellfish phylogeny and the study is most indispensable for culturing shellfish. The correct identification of candidate species of shellfish is very important for successful aquaculture practices.

Course Outcome

Students can easily identify commercially important shellfishes available in Indian coastline

Theory

Study of external morphology and meristic characteristics of crustacea and mollusca.Classification of crustacea and mollusca up to the level of species with examples of commerciallyimportant species.

Practical

Study of external morphology.Collection, preservation and identification of commerciallyimportant prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from naturalhabitats. Field visits for collection and study of commercially important shellfishes.

References

1. Idendification of shell fishes ----FAO
2. Prawn and prawn fisheries of India -----Kurine and Sabestian
3. Identification of shell fishes and Molluscs --- CMRI Special publication

4. Meteorology, Climatology and Geography [FSEM 1101] 2(1+1)

Objective: The aim of this course is to enable students to understand the basic concepts of meteorology and weather events at planetary, synoptic and regional scale.

Course Outcome:

(1) Provide students with a basic understanding of basic meteorology
(2) Students to be able to interpret the general characteristics of weather maps, and further to become familiar with the temporal and spatial representation of meteorological variables (e.g. temperature, atmospheric pressure).
(3) Students will learn about modern methods of weather forecasting and the limitations of computer models.

Theory

Nature of Atmosphere: weather and climate; composition of atmosphere; structureof atmosphere. Heat energy of atmosphere: process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India. Clouds and thunderstorms: amount of cloudiness;ceiling; classification of clouds; conditions of cloud formation; reporting and identification ofclouds; thunderstorms. Atmospheric pressure: meaning of atmospheric pressure; the laws ofGases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients. Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. Tropical cyclones: storm divisions ;pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning. Weather forecasting: forecasting process; forecasting from loca lindications; role of satellite in weather forecasting; synoptic weather charts. Effects of climate change on fisheries sector. Introduction to Geography: shape, size and structure of the earth; concepts

Practical

Graphic representation of structure of atmosphere; physicallayering and compositional layering. Temperature instruments: simple thermometers; Six'sMax-Min Thermometer; thermograph. Isotherms: world mean temperatures-January to July.India mean temperatures - January to July.

Humidity measurement: hygrometer;psychrometer; relative humidity; dew point. Condensation: observation and identification ofvarious types of clouds. Depicting sky picture. Precipitation: measurement of rainfall usingrain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-eastmonsoon and rainfall in December; isohyets. Atmospheric pressure measurement: fortin' smercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetarypressure and wind systems: diagrammatic representation. Geography: The Earth:diagrammatic representation

of shape, size, structure, zones, latitudes, longitudes and greatcircles. Typical landscape mapping; map reading. Geographical terms used in landscape.

References

1. Meteorology -- DrS.R.Ghadekar
2. Physical geography ---- Indra Singh
3. Meteorology ----DrJaman Joseph (CIFNET)
4. Tropical meteorology ----H.Rahil
5. Physical geography (Oceanography) --- K.Bharadwaj

5. Statistical Methods [FSEE 1101] 3(2+1)

Objective: The objective of this course is to provide an understanding for the student on statistical concepts to include measurements of location and dispersion, probability, probability distributions, sampling, estimation, hypothesis testing, regression, and correlation analysis, multiple regression and business/economic forecasting.

Course Outcome:

By completing this course the student will learn to perform the following: 1) How to calculate and apply measures of location and measures of dispersion -- grouped and ungrouped data cases. 2) How to apply discrete and continuous probability distributions to various business problems. 3) Perform Test of Hypothesis as well as calculate confidence interval for a population parameter for single sample and two sample cases. Understand the concept of p-values. 4) Learn non-parametric test such as the Chi-Square test for Independence as well as Goodness of Fit. 5) Compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis, for forecasting and also perform ANOVA and F-test. Further, understand both the meaning and applicability of a dummy variable and the assumptions which underline a regression model. Be able to perform a multiple regression using computer software.

Theory

Definition of statistics, Concepts of population, sample, Census and sample surveys,Classification of data, frequency and cumulative frequency table.Diagrammatic and graphicalrepresentation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequencycurve and Ogives. Important measures of central tendency - arithmetic mean median and mode.Relative merits and demerits of these measures. Important measures of dispersion, Range, MeanDeviation, Variance and Standard Deviation. Relative merits and demerits of these measures.Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis.

Definitions of probability, mutually exclusive and independent events, conditional probability,addition and multiplication theorems.Random variable, concepts of theoretical distribution;Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of samplingdistribution; standard error and central limit theorem. Introduction to statistical inference, generalprinciples of testing of hypothesis, types of errors. Tests of significance based on Normal, t, andChi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure andproperties, linear regression, equation and fitting; relation between correlation and regression, Length weight relationship in fishes; applications of linear regression in fisheries.

Methodologyfor estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Practicals

Construction of questionnaires and schedules.Diagrams and frequency graphs.Calculationof arithmetic mean, median, mode, range, mean deviation, variance, standard deviation. Exerciseson probability, Binomial and Poisson distributions, Area of normal curve ,confidence interval forpopulation mean,

Test of hypothesis based on normal, t, and chi-square. Computation of Simplecorrelation and regression.Fitting of length - weight relationship in fishes.

References

1. Sampling theory of surveys with applications –P.V. Sukhatme and B.V.Sukhatme
2. Statistics , a introducing –D.A.S. Fraser
3. Statistics for biologists --- R.C. Compbell
4. A first coerces in statistics with application ---A.K.P.C. Swain
5. Economics of bio statistics --- S.Prassad
6. Fundamental of mathematics statistics ---S.C.Gupta / V.K.Kapoor
7. Fisheries statstics ----R.C.Biradar

6. Fundamentals of Biochemistry [FSAQ 1112] 3(2+1)

Objective:

To acquaint students with the biochemical functions of different biomolecules.

Course Outcome:

1. Demonstrate an understanding of fundamental biochemistry principles, including topics specific to chemistry and biochemistry.

2. Design, carry out, and record the results of chemical and biochemical experiments using classical techniques, modern instruments, and/or computers, then analyze those results to draw reasonable, accurate conclusions.

Theory

A brief introduction to developments in biochemistry and its transformation to molecularbiology.Cell structure, water and major molecules of life. Carbohydrate chemistry: Structure,classification, functions (mono, di and polysaccharides) isomerism and mutarotation. Metabolismof carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, centralrole of TCA cycle in metabolism. Protein chemistry: classifications and functions. Classification,structure, function and properties of amino acids.Essential and non essential amino acids.Primary, secondary, tertiary and quaternary structure of proteins.Amphoteric property.Biuretreaction and xanthoproteic reaction.Digestion and absorption of proteins.Classification,structure, functions and properties of lipids.Essential fatty acids and phospholipids.Digestionand absorption of lipids.Lipid autooxidation.Significance of Omega-3 and Omega-6 fatty acids.Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics andregulation of enzyme activity. Steroid and peptide hormones- chemistry and function.Structureand functions of fat and water soluble vitamins. Vitamins – classification- functions. Minerals– classification – functions. Nucleic acids: Structure function and importance genetic code.Transcription and translation.Protein synthesis. Energy changes in chemical reactions, reversibleand irreversible reactions in metabolism.

Practical

Preparation of normal solution of acid and base, buffers and reagents.Qualitative determinationof carbohydrates, proteins and lipids.Estimation of total nitrogen and crude protein of fish tissue.Estimation of carbohydrates in foods.Determination of specific gravity of oil.

Extraction andestimation of total lipids in fish tissue.Determination of saponification value, iodine value andfree fatty acid value.

References

1. Biochemistry—A.L.Lehninger
2. Biochemistry -L.Stryer
3. Harper's Biochemistry --- R.K.Murrary and others

7. Fundamentals of Microbiology [FSHM 1107] 3(2+1)

Objective:

1. To impart knowledge on aquatic microorganisms with reference to their role in the aquatic environment and bioprospecting.
2. To impart knowledge of the basic principles of bacteriology, virology, pathogenic microorganisms, pathogenesis, laboratory diagnosis.
3. To acquire requisite skill in the use and care of basic microbiological equipment; performance of basic laboratory procedures in microbiology.

Course Outcome:

1. Demonstrate an understanding of the structure and function of bacterial cells and viruses.
2. Students will be able to explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations;
3. Students will know the theoretical basis of the tools, technologies and methods common to microbiology.

Theory

Milestones in microbiology.Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch,Alexander Flemming, Joseph Lister, Winogrdasky. Microscopy- Principle and constructionofBrightfield, dark field, phase contrast, stereo, SEM and TEM. Microbial taxonomy –Bergy's andmolecular taxonomy Types of Microorganisms: Prokaryotes– Morphology and ultrastructure ofbacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes,archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi andprotozoa. Microbial Techniques - Types of media, types of sterilization - physical and chemicalagents, cultivation of microorganisms, staining techniques – simple, differential, structuralstaining; enumeration of micro-organisms, culture preservation methods. Bacterial metabolism:Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance.Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influenceof physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation- types and significance. Microbial genetics- general principles, genetic recombination,transformation, transduction and conjugation.Plasmids- types and their importance. Mutation–types and significance. Microbial ecology**:** Introduction and types of interaction, extremophilesand their significance.

Aquatic Microbiology:Introduction and **s**cope of aquatic microbiology, aquatic environmentas habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses;distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influenceof physical, chemical and biological factors on aquatic microbes. Microbial biofilms.Role ofmicrobes in the production and breakdown of organic matter.Role of microbes in sedimentationand mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, andmanganese cycles. Sewage microbiology, self

purification in natural waters, sewage treatment,drinking water microbiology, sanitary quality of water for aquaculture, bioremediators.Economicsignificance of aquatic microbes.

Practical

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry-Determination of size of micro organisms (ocular, stage micrometers). Tools and techniquesin sterilization methods:Filteration, dry heat, moist heat, chemical agents Cultivation technique:Media preparation, Isolation -pure culture, subculture. Observation of fungi, blue-green algae,and protozoans.Staining techniques for bacteria– simple, differential, structural and Biochemicaltests: Indole, methyl red, VogesProskauer, citrate test, oxidase test, catalase tests. Collectionof water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation,identification and enumeration of various groups of microorganisms from different water bodiesincluding aquaculture systems.Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform. Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method

References

1. Brock Biology of Micro organisms - Michael T.Madigan, John M.Martnko, Jack Parker
2. Microbiology ----Lancing M.Prescott, John P Harley, Donald A. Klein
3. Microbiology – Michel J plelczar /Jr.E.C.S.Chan, Noel R.Krieg
4. Microbiology essentials and applications ---Larry Mc Kane / Judy Kandel
5. Fundamentals ,principles of bacteriology --- A.J.salle
6. General Microbiology --Hans G.Schlegel
7. Microbiology –A laboratory manual ----------James G.Cappuccine, Netelie Sherman

8. Soil and Water Chemistry [FSEM 1102] 3(2+1)

Objective:

To learn effective soil and water quality management practices which is important for any aquaculture endeavours

Out come

Students will have an insight into the important water and soil quality management and their amalgamation for successful aquaculture operation

Theory

Analytical chemistry: principles, applications and types. Classical methods of analyticalchemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilutesolutions, units of concentration: standard curve; nomograph.

Chemistry of water: the water molecule, properties of pure water, fresh water and sea water.Composition of waters**:** surface water, ground water and sea water. Dissolved gasses: Factoraffecting natural waters. Acid, base, salts: Hydrogen ions, modern concept of pH and buffer.

Water analysis: collection and preservation of water samples. Measurement of temperature.transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids(TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness,Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Waterquality criteria/ requirements for Aquaculture.

Soil Chemistry: origin and nature of soils. Physical properties of soil; soil colour.texture, structure,pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soilcolloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction:acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxesbetween mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils,acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soilsamples. Determination of soil texture, water holding capacity, pH, conductivity, organiccarbon,nitrogen, phosphorus, lime requirement. Soil and water amendments: lime manures,fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination,deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture.

Practical

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry,Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS),computerized instrument system. Demonstration: demonstration of laboratory glass waresand equipment used in water and soil analysis. Water analysis: measurement of temperature,turbidity, determination of pH and EC. Determination of salinity, Chlorinity, Total solids,Redox potential, DO, Free CO2. Determination of total alkalinity,hardness. Determination of inorganic nitrogen, and phosphorus Soil analysis: Determination of soil texture, soil pH,conductivity, soil available nitrogen, available phosphorus, and organic carbon.

References

1. Bottom soil, sediment and pond aquaculture --- Claude E.Body
2. Fundamentals of Soil --- V.N.Sahai
3. Text book of Soil science—R.K.Mehra
4. Soil ----- FAO training series
5. Water quality in ponds for aquaculture --Claude E.Body
6. Fresh water fish culture--- V.R.P.Sinha and V.Ramachandran
7. A hand book of soil, fertilizer and manure – P.K.Gupta

,

9. Fish in Nutrition [FSPT 1101] 1(1+0)

Objective

1. To create basic understanding on the nutritional requirements of fish/shellfish
2. To study about different composition of fish with emphasis on nutritional value, Potential of fish for nutritional security
3. To know about effect of different kinds of processing methods of on nutritional value and quality of fish.

Course Outcome

Students will get their knowledge on

1. Nutritional composition of fish and its health benefits to human being.
2. Fish as an alternate source of protein that form part of a balance diet.

Theory

Composition of fish with emphasis on nutritional value.Concept of Biological value, ProteinEfficiency ratio, Net protein utilization.Amino acids of fish and shellfishes and importance ofessential amino acids. Fish lipids: fatty acids, nutritional quality. Role of fish lipids in humannutrition.Non-protein nitrogen substances in fishes. Vitamins in fish: water soluble, fat soluble,significance in human nutrition. Minerals in fish: micro- and macro-elements, trace elements,significance in human nutrition. Other functional bio-molecules in fish – peptides, collagen andsqualene.Effect of different kinds of cooking fish ie.curry, frying, steaming, smoking, fermentation on nutrition value.

References

1. Biochemistry—A.L.Lehninger
2. Biochemistry -L.Stryer
3. Harper's Biochemistry --- R.K.Murrary and others
4. Biochemistry ---D.Voet and J.G.Voet
5. Elements of Bio chemistry--- H.S. Srivastava

10. Swimming [FSCC 1101] 1(0+1)

Objective:

The main objective of the course is to provide the students with basic knowledge of swimming and to enhance water safety, awareness and confidence in water. To teach the phobia students to overcome fear in water. Emphasis is learn through play and excel in the swimming skill.

Course Outcome:

Student will enhance their swimming skills

Practical

History, hazards in water and safety precautions; pool maintenance andwater qualitycontrol. Learning swimming, understanding and practice of ducking the head, kicking action,holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke);competitive swimming-relays and medleys, lap time practice, swimming and floating aids andtheir uses; diving-styles of diving, rules, regulations and precautions. Methods of life saving inwater; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulationsand practice

SEMESTER – II

1. Fresh Water Aquaculture [FSAQ 1202] 3(2+1)

Objective:

To gain in depth knowledge and field exposure on sustainable aquaculture practices.

Course Outcome

Students will be exposed to various production systems in aquaculture along with species diversification

Theory

Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc. Nursery, rearing and growout ponds preparation and management-control of aquatic weeds and algal blooms, predatory and weed fishes, liming, fertilization/manuring, use of biofertilizers, supplementary feeding. Water quality management. Selection, transportation and acclimatization of seed. Traits of important cultivable fish and shellfish and their culture methods-Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels. Wintering ponds, quarantine ponds and isolation ponds. Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Use of agro-industrial waste and biofertilizer in aquaculture. Composite fish culture system of Indian and exotic carps- competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfish and murrels. Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/ horticulture. Integration of aquaculture with livestock. Cultivation of aquatic macrophytes with aquaculture (makahana). Paddy cum Fish/Shrimp Culture.

Practicals

Preparation and management of nursery, rearing and grow-out ponds. Study on effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Workout of economics of different culture practices.

Estimation of live stock requirement / Unit in integrated aquaculture Design of paddy plot for paddy- cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

References

1. Fish and fisheries of Indian ---- VG Jhingram
2. Fresh water fish culture Vol I and II---- SK Sarkar
3. Text book of fish culture Marcle Huet
4. Aquaculture----Jhon E. Bardasch and Others
5. Aquaculture principles and practices ----TVR Pillay and MN Kutty
6. Encyclopedia of aquaculture ----RR Stickney
7. Fresh water aquaculture----RK Rath

2. Anatomy and Biology of Finfish [FSRM 1203] 3(2+1)

Objective:

Biology is the study of life forms and in this undergraduate course the students will be studying life history events of fishes. Here the life history event of fishes will be dealt with regard to their food and feeding habits, age and growth, maturation and reproductive strategies followed by embryonic and larval development.

Course Outcome:

Students will have a hand on experience about different organs present in fish body along with the importance of these organ for them living processes in fishes

Theory

Study of external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Practicals

Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. Study of food and feeding habits. Analysis of gut contents. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

References

1. Commercial Sea fishes of India – Talwar and Kicker
2. Inland fishes (Vol 1) ----Jhingram and Talwar

3. Inland fishes (Vol 2) ----Jhingram and Talwar

3. Limnology [FSEM 1203] 3(2+1)

Objective:

To educate the students on the ecology of limnetic wetlands and to impart skill and knowledge on the sustainable management of the limnetic ecosystems.

Course Outcome:

Students will get broad vision about the characteristics of limnetic water bodies and methods for efficient management of this vast resources

Theory

Introduction to limnology: inland water types, their characteristics 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; biological relations: influence ofphysical 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: Aquatic plants: characterstics, classification, zonation, seasonal variations, 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. 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.

Practicals

Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies. Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and

biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Field visit to lotic and lentic water bodies.

References

1. Meteorology -- DrS.R.Ghadekar
2. Physical geography ---- Indra Singh
3. Meteorology ----DrJaman Joseph (CIFNET)
4. Tropical meteorology ----H.Rahil
5. Physical geography (Oceanography) --- K.Bharadwaj

4. Marine Biology [FSEM 1205] 3(2+1)

Objective:

To study the biodiversity of flora and fauna and its assessment using the various biodiversity indices for conservation of aquatic resources. To understand the ecological impacts on various resources.

Course Outcome:

Student will study the biodiversity of the coastal areas and device different managerial methods to manage it.

Theory

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, sea weeds, major zooplankton groups. Environmental factors affecting life in the oceans-salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries. Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonations, communities, and the adaptation. Mud banks: formation, characteristics. Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms. Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species, Blooms, Red tides: cause and effects.

Practicals

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, Collection preservation and analysis of inter tidal organisms.

References

1. Commercial Sea fishes of India – Talwar and Kicker

5. Inland Fisheries [FSRM 1206] 3(2+1)

Objective:

To understand the present exploitation and future potential of inland Fisheries. To learn the methodologies for assessments of Inland Fisheries Resources.

Course Outcome:

Students get to know about different types of inland resources and methods to manage these utilized water bodies.

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery present status of their exploitation and future prospects. Cold water fisheries of India.

Practicals

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, net making yards.

References

1. Fresh water inland fishes of India--- K.C.Jayaraman
2. Idendification of shell fishes ----FAO
3. Prawn and prawn fisheries of India -----Kurine and Sabestian
4. Identification of shell fishes and Molluscs --- CMRI Special publication

6. Food Chemistry [FSPT 1202] 3(2+1)

Objective

1. To study about the different composition and nutritional value of food products, benefit of fish for human consumption.
2. To know about different food additives with their chemistry of taste, flavour, odour in food

Course Outcome

Students will get a better understanding of

1. Nutritional compositions of fish as compare other food ingredients for diet.
2. Different food additives, sources and limits for incorporation into food.

Theory

Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydrates: Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic. Lipids: metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Proteins: metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion

with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturized proteins. Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non- nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human

nutrition.

Practicals

Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish sample. Determination of energy value of fish. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Use of pH meter. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods.

References

1. Biochemistry—A.L.Lehninger
2. Biochemistry -L.Stryer
3. Harper's Biochemistry --- R.K.Murrary and others
4. Biochemistry ---D.Voet and J.G.Voet
5. Elements of Bio chemistry--- H.S. Srivastava
6. Howks physiological chemistry B.L.Oser

7. Information and Communication Technology [FSEE 1206] 2(1+1)

Objective:

It prepares the students to participate in a rapidly changing world in which work and other activities are increasingly transformed by access to varied and developing technology.

Course Outcome

Students are well-versed in the use of modern tools like computers and different software

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation;

features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of

A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practicals

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

8. Aquaculture in Reservoirs [FSAQ 1207] 2(1+1)

Objectives:

1. To know the different types of reservoir present in India.
2. To know the suitable cultivable fish species in reservoir.
3. To know the management of different size of reservoir.

Course Outcome:

At the completion of the course the students will have the knowledge about

1. Different culture practices in reservoir (Pen, Cages, etc.)
2. About the productivity of different size of reservoir (small, medium large).

Theory

Definition of reservoirs in India; nature and extent of reservoirs, topography and species diversity; importance of morpho-edaphic index in reservoir productivity and classification; factors influencing fish production; trophic phases in reservoir; pre-impoundment and postimpoundment stages and their significance in establishment of reservoirs fisheries.

Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production.

Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs Role of cage and pen culture in site of cage culture; cage materials,designs, shape, size and fabrication; cage frames and supporting system. Integration of cage ulture with other farming systems. History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture.

Practicals

Preparation of charts on the present situation of reservoirs fisheries productivity; detailed case studies of selected reservoirs on the changing trends in capture fisheries profile; drawing inferences from the analysis of data; suggestions for the sustainable development of reservoirs fisheries. Case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation.

References

1. Aquaculture principles and practices ----TVR Pillay and MN Kutty
2. Encyclopedia of aquaculture ----RR Stickney
3. Hand book fisheries and aquaculture----ICAR New Delhi 2006
4. Sustainable aquaculture ---- BB Jena and Carl D.Webster
5. Hand book of fisheries and aquaculture ---- NIR Board of Consultants (Asia Pacific press)

9. Physical Education, First Aid & Yoga Practices [FSCC 1202] 1(0+1)

Objective:

The main aim of this course is to integrate the body, mind, and thoughts so as to work for good ends. Modern life style leads to diseases, which are mostly due to poor food habits, heavy daily routines and to air and water pollution in turn easily affect the human body.

Course Outcome

These practices make one free from diseases, ignorance, egoism, miseries the affiliations of old age, and fear of death etc.

Practicals

Introduction to physical education: definition, objectives, scope, history, development and importance; physical culture; Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination

and balance; Warming up - General & Specific & its Physiological basis; Test and measurement in physical education; Training and Coaching - Meaning & Concept; Methods of Training; aerobic and an aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems; Balanced

Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports; Governance of sport in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipments, skill, technique, style and coaching of major games(Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first aid. First Aid equipments and up keep. Handling and transport of injured traumatized persons. Emergency procedure for suffocation, demonstration of artificialrespiration. Treatment of injuries (wounds and bleeding)–methods of dressing and bandages; first- aid procedure for injured bones. Handling unconsciousness; Treatment of bums and scalds. Emergency procedure for poisoning with special references to snakebite. Injuries accidents in fishing, fish processing factories, chemical laboratories and their treatments. Shock injuries to muscles and joints and treatments. Sports injuries and their treatments

SEMESTER – III

SEMESTER – III

1. Physiology of Finfish and Shellfish [FSRM 2105] 3(2+1)

Objective

To acquaint students with an insight into physiology of fish/Shell fish in response to changes in the aquatic environment both in the wild and captivity.

Course Outcome

Students get exposers to the living processes in fishes and factors affecting these processes

Theory

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on physiology of fin and shellfishes. Stress related physiological changes. Structure and functions of important endocrine glands.

Practical

Estimation of oxygen consumption, Osmoregulation, ammonia excretion and carbondioxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques

References

1. Fish Physiology ---- Hoar & Randal (1 set – 32 Vol.)

2. Fish Food Organisms [FSAQ2109] 2(1+1) Theory

Objective

To impart basic understanding of the nutritional requirements of fish/shellfish larvae and knowledge on mass culture and enrichment of live food organisms.

Course Outcome

Students learn about mass culture of different live food organisms

Theory

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species. Tropic potentials - proximate composition of live feed. Biology, culture requirements and methodology of important live food organisms; Green algae, blue-green

algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids. Culture of earthworms, bait fish and forage fish.

Practical

Methods of collection and identification of different live food organisms. Laboratory scale culture of selected live food organisms (green algae, spirulina, chetoceros, rotifer, Moina, copepod). Evaluation of live food organisms. Decapsulation and hatching method of brine shrimp cyst.

References

1. A text book of pisciculture and aquarium keeping ---- H.S.Jagtap, S.N.Mukherjee, V.K.Garad
2. Live food organism ---- Manual CIFE
3. Encyclopedia of aquaculture ----RR Stickney

3. Aquatic Ecology, Biodiversity and Disaster Management [FSEM2106] 3(2+1)

Objective

To impart knowledge on the coastal resources, integrated coastal zone management strategies and disaster management.

Course Outcome

Students know about the importance of aquatic ecology and biodiversity and can plan an effective strategies to conserve it in case of any disaster

Theory

Aquatic environment, Flora and fauna: Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries. Conservation programmes for endangered species, *ex situ* and *in situ* conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices.

Disaster Management in Fisheries:

Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India. Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. Causes, characteristics and effects of disasters. Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and nonstructural mitigation measures. During disaster: response and recovery systems at national, state and local, coordination between different agencies, international

best practices. Postdisaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global levels. Sea safety and health. Acquaintance with fire-fighting devices. Life saving appliances and first-aid. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counselling.

Practical

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to angroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices.

References

1. Fundamentals of ecology ---- E.P. Odum, G.W. Barrett
2. Encyclopedia of aquaculture ---- RR Stickney

4. Fishery Oceanography [FSEM 2104] 2(1+1) Theory

Objective

To educate the students on the oceanographic concepts related to fisheries and impart skill to operate oceanographic equipment.

Course Outcome

Students will have knowledge about the chemical and biological processes occurring in the ocean. The can also be able to operate different instruments for analysing different water quality parameters.

Theory

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino. Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution.

Practical

Field visits and operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water

References

1. Physical Geography Oceanography ---- K.Bharadwaj
2. Oceanography for meteorologist ---- H.U.Sverdrup

5. Ornamental Fish Production and Management [FSAQ 2103] 2(1+1) Theory

Objective

To impart knowledge on ornamental fish production, bait fish culture and aquatic ornamental plant propagation.

Course Outcome

Students learn about fabrication of aquarium and mass culture of different live food organisms and aquatic plants. Further we will able to produce ornamental fishes in mass scale.

Theory

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filteration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms, Backyard culture of ornamental fish. Common diseases and their control. Conditioning, packing, transport and quarantine methods. Trade regulations and wild life act in relation to ornamental fishes.Value addition;Colour Enhancement,Genetic manipulation and production of new stains,hybrids

Practical

Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

References

1. Aquarium fishes ---Jena Burton
2. Hand book of fresh water ornamental fishes----S.Mathur, LL Sharma and AK Mathur
3. Profitable fish keeping ----Guy N Smith
4. Aquarium fish keeping ----CLS Srivastava
5. Aquarium management---- Amita Saxena
6. Aquarium plants ---- J.Schmidt

6. Freezing Technology **[FSPT2103]** **2(1+1) Theory**

Objective:

1. To know about the different types of low temperature preservation, handling, storage of different type of fish and fishery products to minimize the spoilage along with post harvest loss.
2. To know about the thawing, quality changes on freezing and its control measures, protective treatments, and different types of packaging materials and methods to be used for packing of frozen fish and fishery products.

Course Outcomes

Students will have better understanding on

1. Preventive measures to reduce or slow down rate of spoilage in post harvest.
2. Maximum keeping quality and types of freezing method to adopt with respect to each fish species and shellfish.

Theory

Introduction to freezing technology; characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants. Principles of low temperature preservations. Chilling of fish – methods and equipment for chilling; icing – quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of antibiotics and chemicals. Freezing of fish fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico– chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish for freezing. Changes that occur during frozen storage – microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments – polyphosphate, glazing, antioxidants, packaging; thawing of frozen fish – methods of thawing. Transportation of frozen fish, cold chain, quality control, HACCP in freezing industry.

Practical

Sanitation and plant housekeeping; chilling and freezing equipment, instruments; packages and product styles; methods of icing fish; cooling rate; preservation by chilled sea water; reezing and thawing curves; freezing of different varieties of fish and shellfish; estimation of drip; determination of quality changes during frozen storage; inspection of frozen fishery products; visits to ice plants, cold storages and freezing plants

References

1. Post-Harvest technology of fish and fish products ---- K.K. Balachandran
2. Fish Products and bi-products ---- K.C.Dora & R.N.Mishra

7. Genetics and Breeding [FSAQ2111] 2(1+1) Theory

Objective:

To impart knowledge on genetic basis of inheritance and breeding plans for commercially important fishes

Course Outcome

Student can effectively select a good quality brood stock for maintaining a low inbreeding depression. They will also get an insight into modern gentical tools like transgenetics, RNAi, Cryopreseservation of gametes etc

Theory

Principles of genetics and breeding, Gene and chromosome as basis of inheritance, Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over. Introduction to population genetics. Hardy- Weinberg law and its significance. Chromosomal structure and aberrations. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

Practical

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt.

References

1. Concept of genetics ---- Kotpal
2. Applied genetics ---- Padhi & Mondal
3. Fish Genetics & Biotechnology ---- W.S.Lakra

8. Fish Immunology [FSHM2106] 2(1+1) Theory

Objective

1. To learn the basic principles of Immunology, types of immunity and antigen-antibody interactions.

2 To understand the defense mechanism in finfish and shellfish and learn the Serological methods in disease diagnosis

Course Outcome

Student will have better understanding on

1. Cell types and organs present in the immune response.

2. Apply basic techniques for identifying antigen antibody interactions.

3. The students will be able to describe immunological response and how it is triggered and regulated.

Theory

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types. epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions- principle, antigenrecognition by B-cells and T cells**.** Antigen-antibody reaction - Precipittin reactions, agglutination reactions, Microorganisms associated with fishes in health and disease. Defense mechanism in finfish and shellfish- specific and non specific immune system. Pathogenicity and virulence.Sources of infection, transmission of disease producing organisms, portals of infection. Immunity to bacteria, fungi and parasites Role of stress and host defense mechanism in disease development. Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants –types, mechanism of action, modes of administration. Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

Practical

Collection, separation and identification of fish leucocytes. Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types of leukocytes and isolation of macrophages. Precipitin reactions - Agglutination test,immunogel diffusion, double immuno diffusion, radial immuno diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

References

1. Fish and Shell fish immunology ---- P.Swain, P.K.Sahoo, S.Ayappan
2. Prevention and control of fish and prawn diseases ----KP Biswas

9. Fisheries Economics [FSEE2102] 3(2+1) Theory

Objective

To familiarise the students with the basic concepts and analytical tools of economics as applied to management decisions. To provide an interface between economics and management decisions.

Course Outcome

Can help the students to effectively manage a fisheries business firm.

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production Contribution of fisheries sector to the economic development of the country. Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost;factors of production, marginal cost and return, law of diminishing marginal return, returns toscale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting. Significance or importance of marginal cost. Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving Forces. Introduction to GATT and WTO. WTO Framework – Key Subjects – Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

Practical

Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products, calculation of price, income and cross elasticities. Production function – production with one or two variable inputs. Shifting demand and surplus curve and its importance in fish price. Economic analysis on cost, return and breakeven of any two production units like fish farm / shrimp farm / seed production unit /fish processing plant / export unit.

References

1. Indian Fisheries and Aquaculture in a globalizing Economy ---- Malhotra & Sinha
2. World fish farming cultivation and economics ---- E Evan Brown

10. Aquatic Mammals, Reptiles and Amphibians [FSRM 2109] 1(1+0) Theory

Objective:

To acquaint the students with the theoretical and practical aspects of the aquatic environment and biodiversity.

Course Outcome

Student will have vivid knowledge on the aquatic biodiversity and their conservation

Theory

Selected aquatic mammal, reptile, amphibian and birds species of India relevant to fisheries: taxonomic status, identification characters, distribution, abundance, habitat, exploitation, threats and conservation. Biology of aquatic animals: Cetaceans (whales. dolphins, porpoises and narwal), Sirenia (manates and dugongs), Carnivora (seals, sea lions walruses, polar bear and otter), Sea turtles, tortoise, crocodiles, sea/freshwater snakes and amphibians. IUCN criteria – Red list, Wild Life (Protection) Act.

References

1. Identification of Prawns and Shrimps of India and their culture ---- A.D.Dholakia

SEMESTER – IV

1. Coastal Aquaculture and Mariculture [FSAQ2204] 3(2+1) Theory

Objective:

To gain knowledge in establishing and managing different fish/shellfish farming systems in coastal waters.

Course Outcome:

Students get an insight into the culture of different commercially important aquaculture species in coastal/marine waters

Theory

An overview of sea farming and shore-based aquaculture in different parts of the world. Resources for shore-based aquaculture and sea farming in India. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds, Seed resources. Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish. Methods of Shellfish Culture rafts, racks, cages, poles and ropes., Water and soil quality management. Estimation of growth, survival and pond productivity. Seaweed culture, Pearl culture, Sea ranching.

Practical

Identification of important cultivable species. Collection and identification of commercially important seed of fish and shellfishes. Types of fertilizers - Pond preparation. Seed selection, quality and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

References

1. Advances in aquaculture----TVR Pillay and Won A Dill
2. Aquaculture –the farming and husbandry of fresh water and marine organisms ---- Bardach, JE JH Ryther, WO MEharney
3. Fisheries sciences ----R Santhanan
4. World fish farming cultivation and economics ---- E Evan Brown
5. Problems of prawn culture (FAO Pub) ---- K Shigeno
6. Brackishwater prawn culture ---- MC Dash and PN Patnaik
7. Prevention and control of fish and prawn diseases ----KP Biswas
8. Publication from CMFRI &CIBA -ICAR

2. Therapeutics in Aquaculture [FSHM 2204] 2(1+1) Theory

Objectives

1. Identify the fundamental principles of Therapeutics in aquaculture
2. Compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class, the risks and benefits, in relation to the organ systems they affect, and the diseases for which they are used therapeutically.

Course Outcome

1. They would have studied in detailed about mechanism of drug action at organ system/sub cellular/ macromolecular levels.

2. They would have understood the application of basic pharmacological knowledge in the prevention and treatment of various fish diseases.

Theory

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms sed and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc.Antibiotic resitance. Antiseptics and disinfectants. Antiparasiticides: Ectoparasites, Endoparasites and Protozoanes. Antibiotics used in aquaculture Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders and dosage. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anaesthetics, flesh color enhancers, Chemicals of therapeutic value, Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices, list of the drugs used in aquaculture with therapeutics.

Practical

Regulations of drug use. Introduction to antimicrobials, preparation of potassium permanganate solution, preparation of weak Tincture Iodine. Minimum inhibitory concentration(MIC). Fiveplate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.

References

1. Fish Pathology ---- Ronald J. Roberts
2. 2. Prevention and control of fish and prawn diseases ----KP Biswas

3. Fish Nutrition and Feed Technology [FSAQ2208] 3(2+1) Theory

Objectives

To learn basic concepts of feed formulation and different feed processing techniques.

Course Outcome

Student can prepare feed based on the nutritional requirements of fish/shell fish.

They can prepare feed using different feed formulations

Theory

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning. Methods of feed formulation and manufacturing. 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. Feed evaluation: feed convertion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Nonconventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutrional deficiency diseases.

Practical

Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality.

References

1. Fish in Nutrition ---- Halver
2. Fish Nutrition in Aquaculture ---- De Silva, Trevor & Anderson

4. Fish Canning Technology [FSPT 2204] 2(1+1) Theory

Objectives

1. To study about the thermal processing/canning and storage of fish and fishery products to prevent microbial spoilage.
2. To know about advantages of canning in relation to other preservation methods, quality standards, plant layout, hygiene, sanitation and waste disposal of fish processing plant.
3. To know about different canning process, equipments, packaging methods and spoilage of canned foods-types, causes and preventive measures.

Course Outcome

Students will have better understanding on

1. Steps/ procedure for canning of fish and shellfish in different style. Pre-requisite procedure, importance of quality of raw materials.
2. Importance of D-value, F –value, Z-value etc

Theory

Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials and sub materials, their characteristics and suitability for canning. Classification of foods based on pH, commercial sterility, Absolute sterility, pasteurisation and sterilization. Canning process, process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Principles of thermal processing. Heat resistance of micro organisms, heat penetration studies, mechanism of heat transfer. Cold spot and its

importance, convection and conduction type of packs. Process calculation by general/ graphical methods, estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate). Commercial sterilization, 12-D concept. Canning of commercially important fin fishes, shell fishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal. Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches.

Practical

Types of cans, canning equipments and layout of cannery. Canning of different varieties of fish and shellfish. Cutout test of canned products. Examination of can double seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method. Study of spoilage condition in canned products. Familiarization with various packaging materials and container for fish products.

References

1. Post-Mortem Changes in Fishes ---- B.K.Khuntia
2. Fish Processing Technology ---- G.M.Hall

5. Fish Packaging Technology [FSPT2205] 2(1+1) Theory

Objectives

1. To study about different types of packaging, importance of packaging in fish processing, functions, objectives and requirements.
2. To know about different types of packaging materials, Properties of packaging materials and their use in protective packaging with special reference to food, and principles of their manufacture and their identification.
3. To know about different packaging equipment machinery, package design, evaluation, testing, handling and transportation procedure of package. Safety and legislation aspects of packing, Labelling and bar coding.

Course Outcome

1. Different types of packaging materials for different fish and fishery products with respect to size, shape, mode of processing and transportation.
2. Importance of labelling.
3. Hazardous and non-hazardous packaging materials for the consumer.

Theory

Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use in protective packaging with special reference to food. Printing for packaging and print identification. Closures of packaging, heat seals bottle closure. Principles of packaging fresh produce handling and transportation. Packaging for retail sale and storage. Packaging equipment and machinery. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials. Laminations and co-extrusions. Retort pouch

packaging - advantages and disadvantages. Biodegradable films, vacuum packaging, active packaging, MAP, Polymeric Packaging.Packaging requirements of fresh fish, Frozen fish, Canned Fish. Transport worthiness of packaging materials, accelerated shelf testing.Materials and their safe use in food contact application. Safety and legislation aspects of packing. Labeling and bar coding.

Practical

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

References

1. Fish Processing Technology and product development ---- A.S.Niwane & Rathnakumar

6. Fish and Shellfish Pathology [FSHM2201] 3(2+1) Theory

Objectives

To provide holistic knowledge on fish and shellfish pathogens and their control measures

Course Outcome

Students know about different types of pathogen and their treatments

Theory

Significance of finFish and Shellfish diseases in aquaculture. Host, Pathogen and Environment Interaction. Disease development process. Stress in aquaculture and its role in disease development. Pathological processes: Cellular response to injury, Inflammatory response to diseases, Pathogencity mechanism of parasite, bacteria, virus and fungus. Casehistory and clinical sign in disease diagnosis. Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals and metabolites, free radicals, oxidants) soil and water parameters in fish health. Nutritional diseases . Non-infectious diseases.

Practical

Live and post mortem examination of fish and shellfish. Pathology of organ systems. Histopathology of normal and diseases fish and shellfish, Diagnosis of abiotic fish diseases.

References

1. Fish Pathology ---- Ronald J. Roberts
2. Prevention and control of fish and prawn diseases ----KP Biswas

7. Fishing Craft Technology [FSFE2203] 2(1+1) Theory

Objectives

To understand the operation of various types of traditional and mechanised fishing craft with better design and modification than the traditional once.

Course Outcome
Student know about different types of fishing craft operated along Indian subcontinent

Theory
Introduction: History & development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History & development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels-longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance oif fishing vessels. Fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines.

Practical
Studies on traditional fishing crafts; Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing; Drawing of back bone assembly; U & V bottom hull of wooden boat; General view of boat; Drawing of sheer plan, body plan and half breadth plan; Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

References
1. Modern Fishing gear technology ---- Hammed & Bhupendranath
2. Fish Catching methods of the world ---- A Von Brandt

8. Fisheries Extension Education [FSEE2207] 2(1+1) Theory

Objectives
To gain insights into different concepts, principles, praxis, recent changes and emerging challenges in fisheries extension. To acquire skills required to practice various fisheries extension approaches.

Course Outcome
Students will transfer the modern and scientific findings of lab to the farmers land thereby increasing the farmer's profitability

Theory
Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of

technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries; Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations; Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation

Practical

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis; case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

References

1. Fisheries Extension ---- Amita Saxena
2. Handbook on Extension Education ---- Rathore, Dhakar, Chauhan & Ojha
3. Entrepreneurship and rural development ---- S.k.Sinha

9. Shellfish Hatchery Management [FSAQ2206] 2(1+1)

Objectives

To provide overall knowledge of seed production and hatchery management of commercially important cultivable crustaceans and molluscs.

Course Outcome

Student can breed commercially important shellfish and can setup his/her own hatchery

Theory

Natural seed resources, site selection and collection methods. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachium rosenbergii*, *P. Vannamei*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe carb, Sepia, Loligo, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon*. and *P. Vannamei*. Induced maturation in *Penaeus monodon* and *P. Vannamei P. Indicus* by eye stalk ablation. Reproductive physiology. Reproductive harmones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and hatchery management of crabslobster, mussel, edible and pearl oyster. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

Practical

Identification of brood stock and maturity stages of important crustaceans and mollusks. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon* P. Vannamei. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/ prawn hatchery.

References

1. Fish & Shell Fish Breeding ---- P.C.Thomas

10. Communication Skills and Personality Development [FSEE2208] 1(0+1)

Objectives

To help the students in building interpersonal skills. 2) To develop skill to communicate clearly. 3) To enhance team building and time management skills. 4) To learn active listening and responding skills.

Course Outcome

On completion of the course, learner will be able to: 1) Make use of techniques for self-awareness and self-development. 2) Apply the conceptual understanding of communication into everyday practice. 3) Understand the importance of teamwork and group discussions skills. 4) Develop time management and stress management.

Practical

Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

References

1. Success Principles ---- Jack Canfield
2. Think and Grow ---- Napoleon hill
3. The power of Positive thinking ---- Norman Vincent

SEMESTER – V

1. Finfish Hatchery Management [FSAQ 3105] 3 (2+1)

Objectives

To learn seed production and hatchery management of commercially important cultivable fishes.

Course Outcome

Student can breed commercially important finfish and can setup his/her own hatchery.

Theory

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Brood-stock management and transportation of brood fish. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea hourse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season andmultiple breeding of carps. Reproductive Biology of IMC, Development, maturation and maintainance of gonads, anatomy of gonads, developmental stages, endocrine control of reproduction, cryopreservation of fish gametes.

Practicals

Study of maturity stages in fishes. Collection and preservation of fish pituitary gland, preparation of PG extract, Hypophysation. Calculation of fecundity. Brood-stock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stages. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.

Suggested Readings-

1. Breeding and Seed Production of Finfish and Shellfish- P.C. Thomas
2. Aquaculture: Principles and Practices - T.V.R.Pillay
3.Freshwater Aquaculture - R.K.Rath
4.Handbook of Fisheries and Aquaculture - ICAR publication

2. Anatomy and Biology of Shellfish [FSRM 3104] 2 (1+1)

Objectives

Students will be studying life history events of shell fishes. Here the life history event of shell fishes will be dealt with regard to their food and feeding habits, age and growth, maturation and reproductive strategies followed by embryonic and larval development.

Course Outcome

Students will have a hand on experience about different organs present in shell fish body along with the importance of these organ for their living processes.

Theory

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

Practicals

Study of Internal Organs commercially important crustaceans and mollusks. Study of Digestive, respiratory, circulatory, nervous and reproductive systems.

Study of food and feeding habits - analysis of gut contents, age and growth, length - weight relationship and condition. Reproductive biology: maturity stages, spawning periodicity, fecundity and larval stages.

Suggested Readings-

1.Text book of fish biology and Fisheries -S.S.Khanna and H.R.Singh
2.Physiology of Finfish and Shell fish -Kasturi Samantaray

3. Pharmacology [FSHM 3103] 3 (2+1)

Objectives

1. Identify the fundamental principles of pharmacokinetics and pharmacodynamics.

2. Compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class, the risks and benefits, in relation to the organ systems they affect, and the diseases for which they are used therapeutically.

Course Outcome

1. Students would have understood the pharmacological actions of different categories of drugs.

2. They would have studied in detailed about mechanism of drug action at organ system/sub cellular/ macromolecular levels.

3. They would have understood the application of basic pharmacological knowledge in the prevention and treatment of various fish diseases.

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs.

Pharmacolotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and Excretion of drugs. Factors influencing drug metabolism. Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non receptor mediated action. Dose Response Relationship, half life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system, and reproductive system. Drugs used in fish transporation. Drug resistance. Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry for aqua-medicines.

Practicals

Introduction to Pharmacy, Metrology, Prescription Writing, Preparation of drug solution for fish/shellfishes, Source and chemical nature of drugs, Incompatability, Pharmacutical technology, Bioassay of drugs, Animal models in Pharmacological experiments, Methods of application of drugs in fish/ Aquaculture.

Suggested Readings-

1.Fish Pharmacology and Toxicology –Govind Pandey
2.Applied Fish Pharmacology - K.M.T.Brown
3.Fish Pathology -Ronald J. Roberts

4. Fish Toxicology [FSHM 3105] 2 (1+1)

Objectives

1. To learn the basic principles of general toxicology, branches of toxicology, classification of poison and diagnosis of poisoning.

2. To learn toxicokinetics, toxicodynamics, systemic toxicology and different types of toxins: phytotoxins, mycotoxins, bacterial toxins.

Course Outcome

1. Demonstrate an understanding of the processes involved in absorption, distribution, metabolism and excretion of toxicants, including an understanding of the toxicokinetic behavior of toxicants in fish.

2. Identify relationships between chemical exposure and effects on physiological systems and design strategies for study of dose-response relationships.

3. Demonstrate an understanding of target organ toxicity involving the following organ systems: liver, kidney, blood, skin, reproductive systems.

Theory

*General Toxicology:*Definitions, Branches of Toxicology, Historical developments, Classification of poison. Types of poisoning- Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetics, Toxicodynamics, General approaches to diagnosis and treatment of poisoning.

*Systemic Toxicology:*Toxicity caused by metal and non-metals, Phytotoxins- Toxic principles of various alkaloids and toxic plants, Drug toxicity and toxicity caused by agrochemicals. Mycotoxins, Bacterial toxins. Collections and dispatch of specimens in Toxicological cases, Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish- Metabolism of toxic substances by aquatic organisms. *Endocrine Disrupture Chemicals (EDC)*

Practicals

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe_3^+), Copper (Cu), Ammonia (ammonium ions) NH_4^+ Chloride (Cl^-), Phosphate ($P0_4$) Sulphate ($S0_4$) Flouride (Fl^-), Qualitative detection of Nitrite and Nitrate, Detection of hydrocyanic acid, Detection and Estimation of Mycotoxins, Test for detection of alkaloids, Estimation of LD_{5O} and ED_{5O} Demonstration of drug toxicity.

Suggested Readings-

1.Fish Pharmacology and Toxicology – Govind Pandey
2.Fish Pathology -Ronald J. Roberts

5. Marine Fisheries [FSRM 3107] 3 (2+1)

Objectives

To know the present level of exploitation of marine resources and to impart knowledge on conservation measures. To learn the recent methodologies of sustainable exploitation of renewable resources.

Course Outcome

Students will know the available marine resources of India and means to protect it

Theory

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic - demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of the India's EEZ. GIS and Remote sensing in marine capture fishery.

Practicals

Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data. Participation in fishing cruises. GIS and remote sensing in marine capture fishery.

Suggested Readings-

1.Marine Fisheries of India -N.G.K.Pallai
2.Handbook of marine fisheries conservation and management- R.Q.Grafton
2.Textbook of Marine Fisheries –A.K.Upadhaya and B.C.Joshi
4.Marine Fisheries Ecology and Management – T.L.Prasad

6. Fisheries Co-operatives and Marketing [FSEE 3104] 2(1+1)

Objectives

To familiarize with the basic concepts and principles of marketing as applied to fisheries. To provide an interface between marketing and management decision.

Course Outcome

Students knows the basics of cooperative marketing and may help in formation of fisheries societies or cooperatives

Theory

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account. Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behavior and marketing research. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India; export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification- export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector. Fisheries organizations: NCDC,FISHCOFED,NFDB,MPEDA

Practicals

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply

using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

7. Fishing Gear Technology [FSFE 3105] 2 (1+1)

Objectives

To learn advanced fishing gear technology, design modification of existing fishing gears and selectivity studies of various fishing gears.

Course Outcome

Student gets greater understanding of different fishing gears used for catching of fishes both in inland and marine waters

Theory

Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG).

Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns.

Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.

Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines. Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system : British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing;, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond; square hexagonal and their measurement. Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velacity, weather resistance, melting point and visibility. Chemical and Biological properties. Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation. Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board

Practicals

Study of net making tools; Knots and hitches used in net making. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing: baiting, creasing and reducing mesh size step by step. Tailoring method : T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination.Joining of net pieces. Net mounting –hanging coefficient, hung depth and their calculation. Selvedging. Methods of net mounting: reeving, stapling and norselling. Mending and net shooter techniques.

8. Fish Population Dynamics and Stock Assessment [FSRM 3108] 3 (2+1)

Objectives

To understand the application of various models to estimate fish population. To get an idea of the interaction of tropical fish population in the ecosystem.

Course Outcome

Students can easily asses the fish/ shell fish population in a given water bodies

Theory

The concept of population and unit stock. Biological structure of fisheries resource in space and time. Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables. Von Bertalanffy growth parameters. Graphical models. Monte Cario simulation model and ECOPATH model. Estimation of total fishing and natural mortality. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models.

The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing. Eumetric fishing. Open access fisheries. Fisheries regulations. CPUE. Trawl selection and gillnet selection. Analytical models of fish stocks.

Practicals

Study of length – weight relationship, segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

9. Coastal Zone Management [FSEM 3108] 2 (1+1)

Objectives

To impart knowledge on the coastal resources, integrated coastal zone management strategies and disaster management.

Course Outcome

Students know about the importance of coastal areas and can plan an effective strategies to conserve it in case of any disaster

Theory

Estuaries, Wet lands and Lagoons, Living resources – Non living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification. Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for main land and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection. Problems related to sectors such as tourism and fisheries in the ICZM context; Analysis of multiple use management problems typical for the coastal areas with the maritime industry. Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries. Evaluation and Methodology; Social Impact Assessment and other developmental activities.

Practicals

Field visit to different coastal environments to study erosion of beaches, Identification of ecologically sensitive areas and protection, Study of CRZ, ICZM along the coastal belt, Study on implementation and violation of CRZ, Study of application of remote sensing and GIS, Project preparation of EIA.

10. Microbial and Parasitic Diseases of Fish and Shellfish [FSHM 2202] 3 (2+1);

Objectives

To comprehend the taxonomy, morphology, pathology and host-parasite relation of common parasites and microbes of aquatic organisms and to understand the significance of parasites and microbial pathogens in fish health.

Course Outcome

Student will know different types of microbial and parasitic diseases in fish/shell fishes and their remedies

Theory

General characteristics, life cycle, diagnosis, prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Vaccines, Immuno-stimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices. SPF and SPR stocks –development and application. Bio-security principles, Sanitary and

phytosanitary Agreement, Disease control through environmental management. Importance of Biofilm, Biofloc, Periphyton in aquatic Health Management, Zoonotic diseases. Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, Rapid diagnostic methods.

Practicals

General procedure for disease diagnosis. Methods of sampling fish and shellfish for disease diagnosis. Taxonomy, lifecycle and identification of fish and shellfish parasites .Sampling, preparation of media and culture of pathogenic bacteria: Techniques for bacterial classification. Techniques in disease diagnosis: Microbiological, haematological, Histopathological, immunological, molecular techniques and Biochemical tests. Agglutination test; Challenge tests; purification of virus; Stress related study of fish and shellfish; Disease treatment.

11. Quality Assurance of Fish and Fishery Products [FSPT 3209] 3 (2+1)

Objectives

1. To know about quality dimensions of seafood, Pre-harvest factors affecting quality & Post harvest factors affecting quality, Assessment of quality changes during processing of fish and fishery products.
2. To know about application of HACCP concept in surveillance and quality assurance programmes for different types of fish and fishery products.
3. To know about quality standards, food laws and regulations, schemes, waste management in seafood processing, complaint handling procedure on fish and fishery products and general requirements for export of fish and fishery products to the EU.

Course Outcome

1. Knowledge on National and International standards associated with fishery products.
2. Biological, physical, chemical, sensory assessment of fish and fishery products.
3. Optimum acceptable limit of quality parameters both national and internationally.

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Pre-harvest and post harvest factors affecting quality. Assessment of quality changes in fresh and iced fish. Quality changes during processing. Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. Food laws and standards, national and international legislation, mandatory and non mandatory standards. Role of export inspection council & export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products, Legislation for export quality assurance in India.Certification system for fish & fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish & fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues. GOI notifications on fish and fishery products. General requirements for export of fish and fishery products to the EU. International regulatory framework for

fish safety and quality. Prerequisites to HACCP, Labelling for product traceability and Labelling requirements- National and international, legislation on labelling, components of traceability code- nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people. EU legislation on traceability of fish and fish products, Assessment of food safety programmes, The HACCP for seafood industries and protection of food from adulterants. Standards for sea foods.FSSA, FDA, ISO.

Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability. Waste management in seafood processing.

Practicals

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

SEMESTER – VI

1. Introduction to Biotechnology & Bioinformatics [FSRM 3210] 2 (1+1)

Objective

To learn various biotechnological applications for enhancing production through sustainable eco-friendly culture.

Course Outcome

Student gets a vivid idea about biotechnological tools used in aquaculture

Theory

Biotechnology**:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes; DNA sequencing, Operons. Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes; Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting. *Genomics*

Bioinformatics**:** Introduction to Bioinformatics; Biological Databases and tools : Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis.

Practicals

Study of structure of prokaryot and Eukaoryt Cells. Study on Model of protein Synthesis, Study of models rDNA Technology, Cell Culture, Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNA sequence analysis and comparison.

2. Refrigeration and Equipment Engineering [FSFE 3202] 3 (2+1)

Objective

To expose the students to design, maintenance of fish processing plant, machinery and the instruments used in fish processing plants.

Course Outcome

Students gets exposed to processing methods used in processing plants

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work-A path function. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, Application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy. Refrigeration: History of refrigeration, Definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system. Refrigeration plant: Layout of refrigeration plant, Construction.

Insulating materials used for the cold storage construction, Frozen product storage capacity of cold storage, usage of Ante-room. Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared toother refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle. Compressors: Definition, Types of compressor, construction, working principle advantages and disadvantages. Evaporator: Definition, Types of Evaporator, construction, working principle advantages and disadvantages. Condenser: Definition, Types of Condenser, Cooling Towers, construction, working principle, advantages and disadvantages. Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Ice-plant: Ice plant planning Brine tank construction, preparation of brine ,Types of ice, Storing of ice, Equipments used in ice plants. Freezers: Definition, Design and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold.

Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated sea water (RSW), Chilled sea water (CSW). Refrigerated transport. Cooling load: Unit of refrigeration, coefficient of performance (C.O.P),Refrigeration effect, study and use of Psychometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipments. Theory of machines: Transmission of power, friction wheels, shaft , gears, belt and Chain drive. Study of equipments used in fish processing with particular reference to canning, sausage, freeze drying and irradiation. Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

Practicals

Drawing of Refrigeration and Fish processing machineries plant layout, Graphically represented symbols used in refrigeration, Handling and operation of compressors, condensers, evaporators expansion valves, low and high pressure switches. Study of auxiliary equipments: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Power transmission line diagram of different fish processing machineries. Visit to processing plant refrigeration plant, Visit to ice plant, Visit to fishing harbor to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

3. Fisheries Policy and Law [FSEE 3203] 1(1+0)

Objective

To understand the planning and policy tools and techniques.

Course Outcome

Student will be exposed to various national and international laws for fisheries and aquaculture regulation

Theory

Introduction to public administration, principles of organization and management of publicenterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Present relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of department of fisheries, corporations and cooperatives. Different central and state level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community based resource management plans. Historical

review of fisheries development and management in India and world. International agencies / organizations for promotion of fisheries worldwide.Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries. Laws relating to conservation and management of fishery resources in marine and inland sectors. Recent changes in land reforms. Land reforms legislation as applicable to aquaculture. Judicial judgments relating to Aquaculture. Objectives, functions and authority of fishery regulatory agencies like Coastal Regulatory Zone (CRZ) and Aquaculture Authority of India. Brackishwater aquaculture act, Marine fisheries policy, Laws relating to fish products and marketing. International Law of the Seas and international commissions on fisheries and their impact. *Odisha Fisheries Policy*

4. Aquatic Pollution [FSEM 3207] 2 (1+1)

Objective

To impart fundamental and advanced knowledge on different aspects of Aquatic pollution and waste water management.

Course Outcome

Students will have better understanding on the sources of aquatic pollution and means to dealt with it

Theory

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment, Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrient

Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget;

Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies. Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution. Solid waste management.

Practicals

Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Study of pathogenic and coliform bacteria. Bacteriological quality of water; Colliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste

waters. Pollution flora and fauna: indicator species- algae, protozoa and insect larva. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.

5. Fishing Technology [FSFE 3206] 2 (1+1)

Objective

To learn engineering aspects of marine engines for effective utilization during fishing and propulsion system of fishing vessels.

Course Outcome

Students will have better understanding on the application of marine engines for fishing operation

Theory

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements. Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid water trawling. Constructional details of single boat purse seine; two boat purse seine and method of operation. Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom , mid water and pelagic gillnetting. Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole & line and trolling line. Operation of long line: set and drift long lining: bottom, mid water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch reducing devices. Deck equipments – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

Practicals

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook & line. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

6. Fish Products and Value Addition `[FSPT 3206] 3 (2+1)

Objectives

1. To study about the different curing and processing methods of value addition and better utilization of low-valued fish.
2. To know about the different methods of packaging and preservation of cured products, hurdle technology, extrusion technology for processed products.
3. To know about the methodology of traditional Indian and Southeast Asian fermented (fish sauce, fish paste etc.) fishery products.

Course Outcome

1. Utilization of low valued fish for production of different value added fishery product.
2. Indigenous and traditionally produce fish products from local and other countries and its method of processing.
3. Packaging materials for different value added fish product to maintain maximum hygiene and shelf-life.

Theory

Principle of fish preservation and processing. Processing offishbytraditional methods– salting,sundrying,smoking,marinading andfermentation. Theoryofsalting,methodsof salting– wetsaltinganddrysalting.Dryinganddehydration- theory,importance ofwater activity in relation to microbial growth. Sun dryingand artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt cured fish. Quality standard for salted and dry fish. Fish preservation by smoking- chemical composition of wood smoke and their role in preservation. Methods of smoking and equipments used for smoking. Carcinogenic compound in wood and method store move them. Hurdle technology in fish preservation and processing. Marinaded and fermented fish products– role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products.

Fermented fish products of Southeast Asia. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibriller protein and their role in elasticity formation. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. and imitation products. HACCP in safe products production.

Practicals

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinaded products. Preparation of surimi and surimi based products. Preparation of diversified and value added fish products. Quality assessment of market sample of dried and fermented fish products.

7. Microbiology of Fish and Fishery Products [FSPT 3208] 3 (2+1)

Objectives

1. To study about history, role and significance of microorganisms in nature in foods.
2. To know about different sources and types of microorganisms in fish and fishery products, Enumeration techniques, factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food.
3. To know about microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation. Food borne pathogens involved in infection and intoxication of food. Different biological hazards associated with fish and fishery products.

Course Outcome

1. Different physical, biological and chemical hazards associated with fish and fishery products. Their preventive measures and elimination.
2. Different enumeration techniques of different hazards.
3. Hygiene and sanitation required during different handling and processing methods.
4. Optimum limits of the microbial load in the fish and fishery products.

Theory

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food.
Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi

processed and processed fish and fishery products. Indicators of microbiological quality of fish and fishery products.

Food borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention. Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

Practicals

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae, Vibrio parahaemolyticus,, E coli, Salmonella, Listeriamonocytogenes* and faecal streptococci. Biochemical tests for characterization of bacteria. Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

8. Navigation and Seamanship [FSFE 3204] 2(1+1)

Objective

To understand engineering aspects of fish acoustics equipment, navigation and seamanship for fishing vessel safety.

Course Outcome

Students will understand the operation of Fishing Trawelers and life saving equipment

Theory

Principles of navigation –terms and definitions, finding positions and method of position fixing magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay points pelorus and azimuth mirror, method of observation. Sextant -parts and functions, finding adjustable and non adjustable errors and principles and use. Hand lead line –construction and markings and method of taking soundings. Types of speed logs –patent log, impeller log, Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions.

The IALA-buoy age systems, cardinal and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system ,storm signals stations Indian coasts, Fog signals, types and methods .Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS Principles of seamanship-Causes fire at sea, fire prevention on board the vessel and method of fire fighting at sea and recommended fire fighting appliances, Life saving appliances –life jackets, life buoys and method of operations and contents, SART and EPIRB. Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law. Preparing vessel to face heavy weather. Temporary repairs for leaks constructions of steering system and rigging emergency jury rudder .types of anchors and their applications. selection of suitable anchorage , procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust , transverse thrust mooring and securing the vessel to the jetty rigging fenders and gangways , and method of leaving vessels from the birth.

Practicals

Anchoring, coming along side the berth and leaving, practicing the different types of knots and wire splices, use of magnetic compass, GPS, Echo-sounder. CHART WORK-Finding positions by latitudes and longitudes by position lines by cross bearing, horizontal sextant, angles, vertical

sextant angle and by running fix, finding position by speed, distance and time findings set and drift of current and findings course made good speed made good and steering course and finding position by counter acting the current observation of RADAR .

9. Fish By-Products and Waste Utilization [FSPT 3207] 2 (1+1)

Objectives

1. To study about better utilization of fisheries waste to develop different types of beneficial by-products.
2. Application and benefits of fish by-products in different fields.
3. To know the methodology of preparation of fish meal, fish liver oil, fish maws & isinglass, fish silage, fish gelatine, fish factice, pearl essence, chitin.

Course Outcome

1. Different methods for preparation of fish by-products those are beneficial to human, Cattle, poultry.
2. Its wide-area of application, in the field of nutrition, medicine, cosmetics, fashions, beverages, etc.

Theory

Fish meal. Dry reduction and wet reduction methods – specification – packaging and storage. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application. Shrimp wastes – chitin – chitosan- production – uses. Fish protein concentrate. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products. Fish silage – acid silage – fermented silage – application. Fishmaws, shark leather, fish glue, fish gelatin, isinglass, pearl essence, shark fin rays, beach-de-mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

Practicals

Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan and fish manure Preparation of acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

10. Fisheries Business Management and Entrepreneurship Development [FSEE 3205] 1(1+0);

Objective

To make the students understand concepts and practices of entrepreneurship skills. To identify a business idea and develop it into a business proposal.

Course Outcome

To enable the future fisheries entrepreneurship to setup their startup

Theory

Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition;

entrepreneurship development programs; Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship.

Preparation of enterprise budget for integrated fish farming. Fiscal and monitory policies and its impact on entrepreneurship. Infrastructural and other financial requirement for fishery entrepreneurship Government policy on Small and Medium Enterprises (SMEs) / SSIs. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of fisheries inputs industry.

Characteristics of Indian fisheries processing and export industry. Introduction to fish business management- Concept of management, management process (planning, organising, staffing, leading and controlling), Organizational behaviour, human resource planning, new dimensions in fish business environment and policies. Accounting procedures of fish business entity. Emerging trends in fish production, processing, marketing and exports. Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs. Globalisation and the emerging business /entrepreneurial environment. Social Responsibility of Business.

11. Aquaculture Engineering [FSFE 2101] 3 (2+1)

Objective:

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

Course Outcome:

Students can design an ideal aquaculture production systems

Theory

Fish Farm- Definition, objectives, types of farms; fresh water, brackish water and marine farms. Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristics.

Land Surveying- definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey. Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling. Plane table surveying- instruments required, working operation, methods. Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour. Calculation of area of regular and irregular plane surfaces, Trapezoidal and Simpson's rule, volume of regular and irregular shape as applied to stacks and heaps, calculation of volume of pond. Earth work calculations- excavation, embankment, longitudinal slope and cross slope, calculation of volume of earth work as applied to roads and channels. Soil and its properties- classification of soil; soil sampling methods; three phase system of soil, definitions of soil properties andpermeability of soil. Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fish ponds, layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds; Types of ponds; nursing ponds, rearing ponds and stocking ponds. Design of ponds, pond geometry;

shape, size, bottom slope of pond *etc*., construction ponds viz., marking, excavation etc., Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes.

Water distribution system- canal, types of canals; feeder canal, diversion canal etc.,Pipe line system, Water control structures- types of inlet and out let and their construction. Water budget equation, Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc., Hatcheries- site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc, Raceway culture system- site selection, layout plan, types of raceway culture system viz.,parallel system, series system etc., Aerators- principles, classification of aerators and placement aerators. Pumps- purpose of pumping, types, selection of pump, total head, horse power calculation. Filters- types and constructions.

Practicals

Evaluation of potential site for aquaculture. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations and water requirement calculation. Visit to different types of farms .

References

1. Aquaculture Engineering - CIFE Manual
2. A Text Book on Aquaculture Engineering -- Rabinarayan Mishra and K.C.Dora

SEMESTER – VII

1. Experiential Learning Module (ELP) on Fish Seed Production [FSEL 4101] 20(0+20)

Objective

Broad objective of the Programme is to guarantee learning opportunity to the undergraduate students through integration of basic knowledge and conceptual aspects with hands on training and practice in a real life work environment. It also aims to install greater confidence, competitiveness and competence among the graduates to meet needs of private sector and to undertake self-employment in vocations of their choice. The specific objectives are as given below. - To induct hands-on training for undergraduate students in fisheries as part of the course curriculum. - To cultivate capabilities suiting emerging job markets and build entrepreneurship spirit and business management competence among students in that they are able to create employment for themselves and others

Course Outcome
To enable the student as future entrepreneur and employer

Sl. No	**Activities**	Credit hrs	date line
1	Orientation, survey and Developing a Business Plan/ Project Proposal with target and species)	(0+1)	1 week
2	Plan for the Production (checklist, Daily activities with date line, methodology/procedure, Group/sub group formation, Procurement of raw materials, marketing strategy etc.,)	(0+1)	1 week
3	Fish Breeding, seed production & Hatchery management, spawn recovery etc	(0+5)	5 weeks
4	Nursery & Rearing management, fry and fingerlings recovery	(0+7)	7 weeks
5	Sales, Marketing and Accounting	(0+4)	4 weeks
6	Documentation & submission of Reports	(0+2)	2 weeks
	Total:	**(0+20)**	**20 weeks**

OR

Experiential Learning Module (ELP) on Post Harvest technology [FSEL 4101] 20(0+20)

Sl. No	**Activities**	Credit hrs	date line
1	Orientation, survey and Developing a Business Plan/ Project Proposal with target and products)	(0+1)	1 week
	Plan for the Production (checklist, Daily activities with date line, Methodology/procedure, Group/sub group formation, Procurement of raw materials, maketing strategy etc.,)	(0+1)	1 week
2.	Prep. of ready to eat value added products (fish cutlet, fish pickle, prawn pickle) and packaging	(0+6) (0+4)	6 weeks 4 weeks
3	Preparation of cured fish products (salted and dried fish) and packaging		
4	Food safety & quality assurance	(0+2)	2weeks
5	Sales & marketing of redy to eat & cured fish products	(0+4)	4 weeks
6	Documentation, submission of Reports	(0+2)	2weeks
	Total:	**(0+20)**	**20 weeks**

SEMESTER – VIII

1. In-plant attachment on Fish seed production [FSRW 4201] 10(0+10)

Objective

Broad objective of the Programme is to guarantee learning opportunity to the undergraduate students through integration of basic knowledge and conceptual aspects with hands on training and practice in a real life work environment. It also aims to install greater confidence, competitiveness and competence among the graduates to meet needs of private sector and to undertake self-employment in vocations of their choice. The specific objectives are as given below. - To induct hands-on training for undergraduate students in fisheries as part of the course curriculum. - To cultivate capabilities suiting emerging job markets and build entrepreneurship spirit and business management competence among students in that they are able to create employment for themselves and others

Course Outcome

To enable the student as future entrepreneur and employer

2. Rural Fisheries Work Experience (RFWE) [FSRW 4201] 10(0+10)

Objective

It enables the students to gain rural experience, give them confidence and enhance on-farm problem solving abilities in real life situations, especially in contact with fish farmers, hatcheries etc.

Course Outcome

It enables the student to deal with real situation of the fish/shrimp farmers and help them to solve their problems

Sl. No	Activities	Credit hrs	date line
1	Orientation	(0+1)	1 week
2	Socioeconomic and Demography survey	(0+1)	1 week
3	Evaluation of the usefulness of present extension system and Government programmes,	(0+1)	1 week
4	Constraints analysis and problem prioritization	(0+1)	1 week
5	Technical & advisory service on participatory mode (Group meetings with villagers, stake holders and officials, Trainings & demonstrations, Exhibitions, cultural activites)	(0+5)	5 weeks
6	Documentation, final report preparation & submission	(0+1)	1 week
Total		**(0+10)**	**10 weeks**