COURSE STRUCTURE AND SYLLABI

of

Bachelor of Fisheries Science (Hons.)

B.F.Sc. (Hons.)

(2024- 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. (Hons.) Degree Programme
SCHOOL OF FISHERIES
Centurion University of Technology and Management

Course Structure

First Semester

Course No	Course title	Credits
ASDA 1101	Deeksharambh	2 (0+2)*
FSRM 1201	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)
FSEM1102	Soil and Water Chemistry	3 (2+1)
FSAQ1202	Freshwater Aquaculture	3 (2+1)
FSHM1101	Fundamental Microbiology	2 (1+1)
FSEM1102	Meteorology and Geography	2 (1+1)
ASAG 1102	Farming Based Livelihood Systems	3 (2+1)
ASEE 1103	Communication Skills	2 (1+1)
ASSW 1101	NCC-I/NSS-I 1	1 (0+1)
	Skill Enhancement Courses* (SEC-I)	2 (0+2)
	Skill Enhancement Courses* (SEC-II)	2 (0+2)
	Total	**25 (10+15)**

*NG= Non Gradial Course.
* The Skill course to be opted from Skill Basket.

Second Semester

Course No	Course title	Credits
FSAQ1208	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)
FSRM1204	Anatomy and Biology of Finfish and Shellfish	3 (2+1)
FSRM1207	Physiology of Finfish and Shellfish	3 (2+1)
FSEM1204	Limnology	2 (1+1)
ASEC 1202	Entrepreneurship Development and Business Management	3 (2+1)
ASAM 1201	Environmental Studies and Disaster Management	3 (2+1)
ASEE 1204	Personality Development	2 (1+1)
ASSW 1202	NCC-II/NSS-II 1	1 (0+1)
	Skill Enhancement Courses* (SEC-III)	2 (0+2)
	Skill Enhancement Courses* (SEC-IV)	2 (0+2)
	Total	**24(12+12)**

* The Skill course to be opted from Skill Basket.

Third Semester

Course No.	Course title	Credits
FSAQ 2204	Coastal Aquaculture and Mariculture	3 (2+1)
FSAQ 2108	Fish Nutrition and Feed Technology	3 (2+1)
FSRM 1206	Inland Fisheries	2 (1+1)
FSFE 2203	Fishing Craft Technology	2 (1+1)
FSPT 2101	Fundamentals of Biochemistry and Food Chemistry	2 (1+1)
FSPT 2102	Post-Harvest Handling and Preservation	3 (2+1)
FSEE 2207	Fisheries Extension	2 (1+1)
ASSW 2103	Physical Education, First Aid, Yoga Practice and Meditation	2 (0+2)
	Skill Enhancement Courses* (SEC-V)	2 (0+2)
	Total	**21(10+11)**

* The Skill course to be opted from Skill Basket.

Fourth Semester

Course No.	Course title	Credits
FSAQ 2205	Breeding and Culture of Ornamental Fish	2 (1+1)
FSAQ 3108	Live Food Organisms for Fish and Shellfish	2 (1+1)
FSHM 2203	Fish and Shellfish Diseases and Treatment	3 (2+1)
FSRM 3107	Marine Fisheries	2 (1+1)
FSFE 2202	Fishing and Gear Technology	3 (2+1)
FSPT 2203	Fish Products, By-products, Value Addition and Waste Management	3 (2+1)
ASEC 3103	Agriculture Marketing and Trade	3 (2+1)
ASAS 2201	Agricultural Informatics and Artificial Intelligence	3 (2+1)
	Skill Enhancement Courses* (SEC-VI)	2 (0+2)
	Total	**23(13+10)**

* The Skill course to be opted from Skill Basket.

Fifth Semester

Course No	Course title	Credits
FSAQ 3106	Fish Genetics and Breeding	2 (1+1)
FSEM 1205	Marine Biology	2 (1+1)
FSRM 3108	Fish Population Dynamics and Stock Assessment	2 (1+1)
FSEM 3104	Aquatic Ecology and Biodiversity	2 (1+1)
FSHM 3104	Pharmacology and Toxicology	3 (2+1)
FSPT 2103	Fish Freezing Technology	2 (1+1)
FSPT 3106	Fish Canning Technology and Packaging	2 (1+1)
FSFE 2101	Aquaculture Engineering	3 (2+1)
FSEE 2102	Fisheries Economics	3 (2+1)
	Education Tour (2 Weeks)	NG
	Total	**21(12+9)**

Sixth Semester

Course No	Course title	Credits
FSAQ 3210	Fish Biotechnology and Bioinformatics	2 (1+1)
FSHM 2106	Fish Immunology	2 (1+1)
FSHM 2204	Therapeutics in Aquaculture	2 (1+1)
FSEM 3108	Coastal Zone Management	2 (1+1)
FSPT 3208	Microbiology of Fish and Fisheries Products	2 (1+1)
FSFE 3202	Refrigeration and Equipment Engineering	2 (1+1)
FSFE 3204	Navigation and Seamanship	2 (1+1)
FSEE 1101	Statistical Methods	3 (2+1)
FSEE 3203	Fisheries Policy and Laws	1 (1+0)
FSEE 3104	Fisheries Co-operative and Marketing	2 (1+1)
	Total	**20(11+09)**

Seventh Semester

Course No	Course title	Credits
ELECTIVE COURSES (MAJOR)*		
FSAQ 4101	Open-water Aquaculture	3 (2+1)
FSAQ 4102	Smart Aquaculture Production Systems	3 (2+1)
FSHM 2201	Fish and Shellfish Pathology	3 (2+1)
FSHM 4102	Disease Diagnostics Techniques	3 (2+1)
FSRM 4101	Sustainable Fisheries Management and Conservation	3 (2+1)
FSEM 3207	Aquatic Pollution	3 (2+1)
FSEM 2104	Fishery Oceanography	3 (2+1)
FSEM 4103	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)
FSPT 3209	Quality Assurance of Fish and Fishery Products	3 (2+1)
ELECTIVE COURSES (MINOR)*		
FSAQ 4203	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)
FSHM 4203	Aquatic Microbiology	2 (1+1)
FSRM 4202	Climate Change and its Impact on Fisheries	2 (2+0)
FSRM 4203	GIS and Remote Sensing in Fisheries	2 (1+1)
FSFE 4201	Responsible and Sustainable Fishing Methods	2 (1+1)
FSPT 4202	Principles and Techniques of Seafood Analysis	2 (1+1)
FSPT 4203	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)
FSEE 4201	Marketing Intelligence and Business Analysis	2 (1+1)
FSFE 1206	ICT in Fisheries	2 (1+1)
	Total	**20 Credits**

*Students have the option to choose any 4 major courses and 4 minor courses from the list of courses

Eighth Semester

Course No	Course title	Credits
FSRW 4301	In-plant/ Industry Attachment (for 8 weeks)	5 (0+5)
FSRW 4302	Rural Fisheries Work Experience (RFWE) Program (for 8 weeks)	6 (0+6)
FSEL 4301	Experiential Learning Program (ELP)	6 (0+6)
FSPR 4301	Project Work	2 (0+2)
FSSM 4301	Seminar	1 (0+1)
	Total	**20 (0+20)**

Objectives of the B.F.Sc. (Hons.) Course

Bachelor of Fisheries Science (Hons.), B.F.Sc.(Hons.) is an under graduate course, which involves farming and husbandry of important fishes and aquatic organisms in fresh water, brackish water and marine environment. The course also deals with the breeding habits and habitats of various species of fish. Similarly, the course deals with the art of fish harvesting and the science involved in fish processing; besides fish marketing and conservation of fish. Furthermore, the course deals with the improvement of fishermen's community and recognizes the need to protect and enhance the role of fisherwomen in the fisheries economy.

The main objectives of this course is

1. To provide quality education for the development of professionally qualified and technically skilled human resource man power to the fisheries sector of the country.
2. To undertake fisheries research and extension activities for enhanced fish production
3. To find out solutions to the problems encountered by the aqua farmers, fisher folk and entrepreneurs
4. To alleviate poverty and ascertain nutritional security of the country
5. To achieve overall development of the fisheries sector and conservation of fish for sustained growth.

Programme Learning 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 relation 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

Outcome of the course

Upon successful completion of the Bachelor of Fisheries Science (Hons.), B.F.Sc. (Hons.) degree programme, graduates will be qualified to work as Fisheries Development Officers in the State Governments; Technical/Specialist/Market Recovery Officers in Banks; Officers in Insurance Companies; Technical officers in States/Central Fisheries Institutions. Post graduates with Ph.D qualification are eligible for Scientist/Assistant Professor in Central/State Organizations and Universities.

The B.F.Sc. (Hons.)students also have the option for Government of Odisha Administrative Jobs through Odisha Public Service Commission (OPSC) examination; where fisheries subject has been included as one of the compulsory course.

The 4 year B.F.Sc. (Hons.)degree course offers a great scope to the students for self-employment in establishing Farms/Hatcheries/Processing Plants and Fish Export Business. The B.F.Sc. (Hons.)graduates have very good career opportunities in the respective field, as it is less saturated compared to other agriculture related fields and there is a huge scope for development of fisheries in the county.

SEMESTER – I

1. Deeksharambh [ASDA 1101] 2(0+2)

The activities to be taken under Deeksharambh shall aim at creating a platform for students to

1. Help for cultural Integration of students from different backgrounds
2. Know about the operational framework of the academic process in the university
3. Instilling life and social skills
4. Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
5. Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenarios.

The details of activities will be decided by the parent universities. The structure shall include, but not restricted to:

- Discussions on the operational framework of the academic process in the university, as well as interactions with academic and research managers of the University
- Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
- Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experience.
- Activities to enhance cultural Integration of students from different backgrounds
- Field visits to related fields/ establishments
- Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

2. Taxonomy of commercially important fish and shellfish [FSRM 1201] 3(1+2)

Objectives:

1. To understand basic classification and taxonomic features of commercially important fish and Shell fishes.
2. To impart knowledge on the identification of cryptic species both in family and species level
3. To provide basic knowledge on the use of modern molecular taxonomic tools.

Outcomes:

1. Enhanced knowledge on the basic taxonomic classification of fish and shellfish .
2. Skill to identify the fishes and shell fish based on the morphomeristic characteristics.
3. Knowledge on differentiating cryptic species in fishes.

4. Acquire knowledge to collect, label and preservation of fish and shell fish specimen.
5. Understand the use of modern taxonomic tools.

Theory:

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyo-taxonomy, DNA barcoding, protein analysis and DNA polymorphism.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 commercially important species.

Practical:

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism; Visit to fish landing centres to study commercially important fishes and catch composition. Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, and cephalopods from natural habitats. Field visits for collection and study of commercially important shellfish.

Suggested readings:

1. Bal DV and Rao KV. 1990. Marine Fishes of India. 1st Revised edn. Tata McGraw Hill.
2. Day F. 1878. The Fishes of India. William Dawson and sons Ltd.
3. FAO. 2000. DNA-based molecular diagnostic techniques.
4. Fischer W and Biachi G. 1984. FAO-identification sheets for fishery purposes. Vol I-VI pages' variable
5. Hamilton F. 1822. Fishes of the River Ganges and its branches. Publ. Edinberg.
6. Jayaram KC. 2010. The freshwater fishes of the Indian Region II edition. Narendra Publishing house New Delhi
7. Kurian CV and Sebastian VO. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
8. Jayaraman KC. 2002. Fundamentals of Fish Taxonomy. Publ.
9. Mayr E. 1977. Principles of Systematic Zoology. Tata Mc Graw Hill Publishing Co. Ltd. New Delhi, p. 428.
10. Nelson JS. 2006. Fishes of the World, 4th edn, John Wiley and Sons.
11. Ponniah AG and George John. 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow publication.
12. Talwar PK and Jhingran AG. 1991. Inland fishes of India and adjacent countries, Delhi Oxford and IBH Publishing Co. Pvt. Ltd. 1158 p. Vol. I and II.
13. Talwar PK and Kacker RK. 1984. Commercial Sea Fishes of India. ZSI, Kolkata. 997p
14. Thomas D, Kocher and Carol A Stepien (Ed.). 1997. Molecular Systematics of Fishes. Academic Press. New York. 314p.

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

Objectives

1. To analyze and explain the physical and chemical composition of soil and water.
2. To understand principles, applications, methods and types on analytical chemistry.
3. To impart knowledge on the interaction between soil and water, including adsorption, desorption and ion exchange.

Outcomes:

1. Understand the water and soil parameters analysis for aquaculture.
2. Aware of optimum ranges of water and soil parameters for aquaculture.
3. Describe soil and water interaction processes.
4. Understand redox reaction and electron transfer.
5. Familiarize with common laboratory techniques for analyzing soil and water samples.

Theory

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute
solutions, 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: Factors affecting 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. Water quality 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: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, and soil reclamation.

Soil analysis: collection and preparation of soil samples, determination of soil texture, water holding capacity, pH, conductivity, organic carbon, 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 wares and 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.

Suggested readings:

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd Edition. American Public Health Association, Washington, D.C
2. Boyd, C.E., Wood, C.W. and Thunjai, T. 2002. Aquaculture pond bottom soil quality management. Oregon State University, Corvallis, Oregon.
3. Bryan M Ham and Aihui MaHam. 2016. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, Wiley.
4. Cheremisinoff NP. 2002. Handbook of Water and Waste Water Treatment Technologies. Butterworth – Heinemann, Woburn.
5. Jeffery GH, Basset J, Mendham J and Denney RC. (Eds). 1989. Vogel's Textbook of Quantitative Chemical Analysis. Longman Publishers, Singapore.
6. Sparks DL, Page AL, Helmke PA, Loeppert RH, Soltanpour PN, Tabatabai MA, Johnston CT and Sumner ME. (Eds). 1996. Methods of Soil Analysis: Part 3 - Chemical Methods. SSSA ASA, Madison.

4. Freshwater Aquaculture [FSAQ 1202] 3(2+1)

Objectives:

1. To gain knowledge and understand the recent advances in freshwater aquaculture under different culture systems
2. To impart the knowledge of the different types of aquaculture methods and commercially importable freshwater fish and shell-fish species
3. To understand recent innovations and implications in aquaculture.

Outcomes:

1. Understanding of the history of aquaculture and different production systems employed for better production.
2. Gain knowledge on different types of culture systems and water bodies for fish culture.
3. Understand the steps involved in pond management prior to beginning of any aquaculture systems.
4. Ability to identify important candidate species for aquaculture.
5. Develop skills in production, management and economics of different aquaculture systems.

Theory:

Major species cultured, production trends and prospects in different parts of the world. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs, etc. Nursery, rearing and grow out 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, freshwater 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 Indianand exotic carps-competition and compatibility. Exotic fish species introduced to India. Culture of other freshwater species. Medium and minor carps, catfishes 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.

Practical:

Preparation and management of nursery, rearing and grow-out ponds. Study on the 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 the economics of different culture practices. Estimation of livestock 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.

Suggested readings:

1. Agarwal SC. 2008. A Handbook of Fish Farming. 2nd edn. Narendra Publ. House.
2. De Silva SS. (Ed.). 2001. Reservoir and Culture Based Fisheries: Biology and Management. ACAIR Proceedings.
3. FAO. 2007. Manual on Freshwater Prawn Farming.
4. Midlen and Redding TA. 1998. Environmental Management for Aquaculture. Kluwer.
5. New MB. 2000. Freshwater Prawn Farming. CRC Publ.
6. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
7. Pillay TVR. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambridge University Press, Cambridge.
8. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
9. Venugopal S. 2005. Aquaculture. Pointer Publ.
10. Welcomme RL. 2001. Inland Fisheries: Ecology and Management. Fishing News Book
11. ICAR. 2006. Handbook of Fisheries and Aquaculture.
12. Jhingran V.G. 1991. Fish and Fisheries of India, 3rd edn, Hindustan Publ.

5. Fundamental Microbiology [FSHM 1101] 3 (2+1)

Objectives:

1. To impart knowledge of the basic principles of bacteriology, virology, pathogenic microorganisms, pathogenesis, laboratory diagnosis.
2. To impart knowledge on aquatic microorganisms with reference to their role in the aquatic environment and bio-prospecting.

3. To acquire requisite skill in the use and care of basic microbiological equipment; performance of basic laboratory procedures in microbiology.

Outcomes:

1. Understand chronological events in microbiological discoveries.
2. Knowledge on classification, structure and function of micro-organisms.
3. Gain knowledge on theoretical basis of tools, technologies and methods common to microbiology.
4. Developed skill on culture of micro-organisms and their identification.
5. Gain knowledge on microbial characterization in aquatic environment.

Theory

Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogrdasky. Microscopy- Principle and construction of brightfield, dark field, phase contrast, stereo, SEM and TEM. Microbial taxonomy–Bergy's and molecular taxonomy. Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi and protozoa. Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining; 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- influence of 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, extremophiles and their significance. Aquatic Microbiology: Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses. Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self-purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators. Economic significance of aquatic microbes.

Practical

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry. Determination of size of microorganisms (ocular, stage micrometers). Tools and techniques in sterilization methods: Filtration, 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 Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies

including 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.

Suggested readings

1. Chakraborthy P. 1995. A Text Book of Microbiology. New Central Book Agency.
2. Criusted J. 1986. Methods in Microbiology. Academic Press.
3. Harry WSJR, Paul JV and John JL. 2000. Microbes in Action. Freeman andCo.
4. James M. 1978. Modern Food Microbiology. 2nd edn. D. Van Nostrand Co.
5. Michael J, Pelizar JR and Chan ECS. 1998. Microbiology. Tata McGraw Hill.
6. Paul JH. 2001. Marine Microbiology - Methods in Microbiology. Vol. XXX. Academic Press.
7. Samuel CP and Dunn CG. 1959. Industrial Microbiology. McGraw Hill.
8. Silliker JH, Elliof RP, Baired AC and Boyan FL. 1980. Microbial Ecology of Foods. Vol. II (ICMSF). Academic Press.
9. William CF and Westhoff DC. 2000. Food Microbiology. Tata Mc Graw Hill.
10. Khuntia B. K. 2021. Basic Microbiology- A Illustrated Laboratory Manual. Daya Publ.

6. Meteorology and Geography [FSEM 1102] 2(1+1)

Objectives:

1. To understand the meteorological, climatology and geographical aspects of the earth that influences almost all activities of living beings.

2. To impart knowledge on interpreting the general characteristics of weather maps.

3. To study and analyze temporal and spatial representation of meteorological variables.

Outcomes:

1. Understand the composition and structure of the atmosphere.
2. Skilled to analyze meteorological data, interpret climate trends, and apply geographic tools for spatial analysis.
3. Knowledge of wind patterns and tropical cyclones.
4. Familiarization with modern methods of weather forecasting.
5. Capability to utilize geographic tools for spatial analysis, and recognize the environmental implications of weather and climate phenomena.

Theory:

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: the process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of the atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: the 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 of clouds; thunderstorms. Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; 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 local indications; 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 of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape.

Practical:

Graphic representation of the structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph. Isotherms: world mean Temperatures-January to July. India means temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets. Atmospheric pressure measurement: Fortin's mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Wind observation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and great circles. Typical landscape mapping; map reading. Geographical terms used in landscape.

Suggested readings

1. Ahrens, C. Donald. 2011. Essentials of Meteorology: An Invitation to the Atmosphere, International Edition, Brooks/Cole Publ.
2. Barry Roger G. 2009. Atmosphere, Weather and Climate, Taylor and Francis Ltd.
3. Maury, Matthew Fontaine. 2018. The Physical Geography of the Sea, and Its Meteorology, Palala Publ.
4. Naik M. Ganapathi . 2013. Meteorology and Geography, Narendra Publishing House.
5. Spiridonov V. 2021. Fundamentals of Meteorology, Springer.
6. The Indian Meteorological Department (IMD), Weather Instruments, Maps and Charts, In
7. Practical Geography. 2022-23.

7. Farming Based Livelihood Systems [ASAG 1102] 3(2+1)

Objectives:

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill, and how farming-based systems can be a source of
   livelihood.

3. To Understand the interplay between farming, income generation, food security, and resilience.

Outcomes:

1. Gain knowledge on different Farming Systems.
2. Develop critical thinking ability for Sustainable Farming Practices.
3. Gain Knowledge about Livelihood Diversification and Resilience.
4. Students will gain awareness of the role of gender and social issues in farming.
5. Students will learn how climate change affects agricultural productivity and the livelihood security of farming households..

Theory:

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock, (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., small, medium and large enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting the integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style

Practical:

Survey of farming systems and agriculturally based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop-based, livestock-based, processing-based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about the concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors

Suggested readings:

1. Agarwal, A. and Narain, S. (1989). Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India

2. Ashley, C. and Carney, D. (1999). Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK. Volume 7. [Google Scholar]

3. Carloni, A. (2001) Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy

4. Dixon, J. and Gulliver A. with Gibbon, D. (2001). Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & and World Bank, Rome, Italy & and Washington, DC, USA

5. Evenson, R.E. (2000). Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy

6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, Amitava Dey Ujjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar

7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.

8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.

9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.

10. Walia, S. S. and U. S. Walia, 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

8. Communication Skills [ASEE 1103] 2(1+1)

Objectives:

1. To acquire competence in oral, written and non-verbal communication,
2. To develop strong personal and professional communication and demonstrate positive group communication.
3. To cultivate active listening, empathy, and assertiveness for effective teamwork and conflict resolution.

Outcomes:

1. Speak and write with clarity, coherence, and confidence across various settings..
2. Knowledge on the chemistry and classification of different biomolecules.
3. Deliver compelling presentations, craft impactful resumes, and maintain formal correspondence.

4. Engage constructively in team activities, resolve conflicts diplomatically, and build positive relationships.
5. Communicate persuasively with diverse audiences and handle multicultural interactions with sensitivity.

Theory:

Theory Communication Process: The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication. Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions. Structural and Functional Grammar: Sentence structure, modifiers, connecting words and verbals; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults.

Practical:

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed; Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested readings

1. Allport, G W, 1937, Personality: A Psychological Interpretation. Holt, New York.

2. Brown Michele and Gyles Brandreth, 1994, How to Interview and be Interviewed. Sheldon Press, London.

3. Carnegie Dale, 1997, The Quick and Easy Way to Effective Speaking. Pocket Books, New York.

4. Francis Peter S J, 2012, Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.

5. Kumar S and Pushpa Lata, 2011, Communication Skills. Oxford University Press.

6. Neuliep James W, 2003, Intercultural Communication- A Contextual Approach. Houghton Mifflin Co Boston.

7. Pease, Allan, 1998, Body Language. Sudha Publications, Delhi.

8. Raman M and Singh P, 2000, Business Communication. Oxford University Press.

9. Seely J, 2013, Oxford Guide to Effective Writing and Speaking. Oxford University Press.

10. Thomson A J and Martinet A V, 1977, A Practical English Grammar. Oxford University

9. National Cadet Corps (NCC-I) /National Service Scheme (NSS-1) (ASSW 1101] 1(0+1)

Objectives:

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation
3. Demonstrate a deep sense of loyalty and responsibility toward the nation.

Outcomes:

1. Showcase improved physical fitness, mental resilience, and ethical values.
2. Lead teams effectively, work collaboratively, and make informed decisions.
3. Contribute actively to social welfare projects and address community challenges.
4. Use acquired life skills to assist in disaster relief, first aid, and crisis management.
5. Gain knowledge on NSS/NCC Activities.

Practical:

Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline. • Drill- aim, general words of command, attention, stands at ease, stand easy and turning. • Sizing, numbering, forming in three ranks, open and close order march, and dressing. • Saluting at the halt, getting on parade, dismissing, and falling out. • Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march. • Marking time, forward march, and halt. Changing step, formation of squad and squad drill. • Command and control, organization, badges of rank, honors, and awards • Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defence organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects. • Basics of social service, weaker sections of society and their needs, NGO's and their contribution, the contribution of youth towards social welfare and family planning. Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

National Cadet Corps (NCC-I)

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Practical:

Orientation: history, objectives, principles, symbol, badge; regular programs under NSS • Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health. • NSS program activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change. Community mobilization. Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration • Indian history and culture, role of youth in nation building, conflict resolution and peace building. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism • Citizenship, constitution, and human rights. Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community based organizations) and society

SEMESTER - II

1. Fish and Shell fish Breeding and Hatchery Management [FSAQ 1208] 3(2+1)

Objectives:

1. To impart adequate knowledge about the life cycle and maturity stages of commercially important Fish and Shell fish .

2. To understand the induced breeding of commercially important Fish and Shell fish.

3. To understand hatchery management and rearing techniques of commercial Fish and Shell fish.

Outcomes:

1. Understand the life cycle and maturity stages of commercially important Fish and Shell fish

2. Gain knowledge of Induced breeding of commercially important Fish and Shell fish.

3. Understand the reproductive hormones and the physiology of different Fish and Shell fish.

4. Develop skills in hatchery management and rearing techniques of commercially important Fish and Shell fish.

5. Health and feeding management of larval stages of important Fish and Shell fish in hatcheries.

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. 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 carp, mahseer, trout, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea horse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps. 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, P. vannamei and P. indicus by eye stalk ablation. Reproductive physiology. Reproductive hormones in crustaceans. Brood stock management of Penaeus monodon and Macrobrachium rosenbergii. Breeding and hatchery management of P. monodon and M. rosenbergii. Breeding and hatchery management of crabs, lobster, mussels, edible and pearl oysters. Food and feeding of larval stages of important shellfishes. Health management in hatcheries

Practical:

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 anaesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes. Identification of brood stock and maturity stages of important crustaceans and molluscs. Observations on gonadal maturation of Penaeus monodon and Macrobrachium rosenbergii. Breeding and larval rearing of Macrobrachium rosenbergii, Penaeus monodon, and P. vannamei. Identification of larval stages of important crustaceans and molluscs. Demonstration of eyestalk ablation in Penaeus monodon. Collection, packing and transportation of shrimp/prawn seed and brood stock. 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.

Suggested Reading:

1. FAO. 1992. Manual of Seed Production of Carps. FAO Publ.

2. Gupta SD, Mohapatra PC, Routray P, Sahoo SK, Verma DK, Sarangi N. 2008. Textbook of Breeding and Management of Carps. Narendra Publ. House

3. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.

4. Jhingran VG and Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.

5. Landau M. 1992. Introduction to Aquaculture. John Wiley and Sons.

6. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.

7. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.

8. Thomas PC, Rath SC and Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.

9. Kurian, C.V. and Sebastian, V.O., 1976. Prawns and prawn fisheries of India, Hindustan Pub. Corp., Delhi.

10. CMFRI 2009. Training Manual on Breeding and Larval Rearing of Marine Finfishes

and Shellfishes.

11. Diwan AD, Joseph S and Ayyappan S. 2008. Physiology of Reproduction, Breeding and Culture of Tiger Shrimp. Narendra Publ. House

12. FAO 2007. Assessment of Freshwater Fish Seed Resources for Sustainable Aquaculture. FAO Fisheries Technical Paper No. 501.

13. Chakraborty C and Sadhu AK. 2000. Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publ. House.

2. Anatomy and Biology of Finfish and Shell fish [FSRM 1204] 3(2+1)

Objectives:

1. To acquire knowledge on the internal and external anatomy, various organ systems in Fish and Shell fish and their functions
2. To understand the functions and interconnections of these systems in Fish and Shell fish, and their role in maintaining life processes.
3. To examine the reproductive biology of Fish and Shell fish, life history stages, developmental biology, age and growth determination, fish migration, tagging, and marking techniques.

Outcomes:

1. Knowledge of Fish and Shell fish Anatomy.
2. Gain a comprehensive understanding of the circulatory, respiratory, nervous, urogenital, endocrine, skeletal, and sensory systems in Fish and Shell fish.
3. Ability to assess the reproductive biology of Fish and Shell fish, including maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio, and spawning behaviors.
4. Acquire the skills to determine the age and growth of Fish and Shell fish using both direct and indirect methods.
5. Understand the types and significance of Fish and Shell fish migration and gain knowledge of tagging and marking techniques used in fisheries research.

Theory:

Study of the 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. 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

Practical:

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. Study of Internal Organs commercially important crustaceans and molluscs. 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. Barrington EJW. 1981. Invertebrate Structure and Function. 2nd edn. The English Language Book Society and Nelson.

2. Ede DA. 1978. An Introduction to Developmental Biology. Blacki

3. Jobling M. 1995. Environmental Biology of Fishes. Chapman and Hall.

4. Jobling M. 1995. Environmental Biology of Fishes. Springer.

5. Khanna, S.S. and Singh, H.R. 2014. Textbook of Fish Biology and Fisheries. 3rd edn. Narendra Publishing House.

6. Paul, J., Hart, B. and Reynolds, J. D. (Editors), 2002. Handbook of Fish Biology and Fisheries: Fisheries, Volume 2, Blackwell Science Ltd.

7. Ray, Samanta. 2015. Physiology of Finfish and Shellfish.: New Delhi New India Publishing Agency 2015: “xviii, 230p” ISBN: 978-93-83305-68-1

3. Physiology of Finfish and Shellfish [FSEM 1207] 3(2+1)

Objectives:

1. To understand the fundamentals of Aquatic medium, basic physiological mechanisms in finfish and shellfish and their adaptations to aquatic environments.

2. To examine and understand the energy and nutrient status of food in these aquatic organisms.

3. To investigate and analyze the impact of environmental factors and their implications for the health and well-being of aquatic organisms.

Outcomes:

1. Understanding of the fundamental principles of water as a biological medium and its role in the physiology of finfish and shellfish.

2. Knowledge on the mechanisms of gas exchange, circulation, excretion, osmoregulation, and how these processes are adapted for life in aquatic environments.

3. Understands the hormonal control of reproduction, gametogenesis, and reproductive behaviors in finfish and shellfish.

4. Knowledge on the muscle physiology, the function of sensory organs, and the energy and nutrient utilization in aquatic organisms.

5. Able to assess the effects of environmental factors on the physiology of finfish and shellfish, and propose the management strategies**.**

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 the physiology of fish and shellfish. Stress-related physiological changes. Structure and functions of important endocrine glands.

Practical:

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

Suggested Reading:

1. Diwan. 2007. Physiology of Marine White Shrimp: Fenneropenaeus indicus. Delhi Narendra Publishing House.

2. Evans DH and Claiborne JB. 2006. The Physiology of Fishes. CRC Press.

3. Evans, 2014. Physiology of Fishes. Boca Raton CRC Press 2014, 4th Edition.

4. Hoar WS and Randall DJ.1988. Fish Physiology. Academic Press.

5. Johnston, 2014. Fish Physiology (Series 1-35 volumes) New Delhi Reed Elsevier India Pvt. Ltd.

6. Ray Samanta. 2015. Physiology of Finfish and Shellfish. New Delhi, New India Pub. Agency.

7. Reinecke, 2006. Fish Endocrinology, Vol. 1. Enfield Science Publishers, Inc.

8. Reinecke, 2006. Fish Endocrinology, Vol. 2: Enfield Science Publishers, Inc.

9. Rocha 2008. Fish reproduction. Enfield Science Publishers, Inc.

10. Smith Lynwood S. 1999. Introduction to fish physiology. Narendra Publishing House.

4. Limnology [FSEM 1204] 2(1+1)

Objectives:

1. To understand dynamics and distribution of different lentic and lotic water bodies.
2. To impart knowledge on physical chemical and biological components of freshwater ecosystem.
3. To get familiarized with biotic and abiotic factors of lentic and lotic environments

Outcomes:

1. Gained knowledge on differentiation between various types on aquatic systems and their characteristics.
2. Identification of major groups of aquatic organisms and their ecological goals.
3. Understand the distribution and dynamics of plankton and benthos of freshwater bodies.
4. Understand the classification of lentic and lotic environments.
5. Understand the dynamics of lotic ecosystems including flow pattern and sediment transport.

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 of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton; seasonal changes of body form in planktonic organisms; food of planktonic organisms; primary productivity: Aquatic plants: characteristics, 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

Practical:

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.

Suggested Reading:

1. Textbook of limnology: G. Cole and P. Weihe, Waveland Press, Illinois, USA (2015).
2. Limnology: Horne J. Alexander, Goldman and R. Charles,. McGraw Hill Inc. New York (1994).
3. Limnology in the Indian sub-continent: Irfan Ali khan and Atiya Khannum, Ukaaz Publications, Hyderabad (2005).
4. Hydrology and hydrobiology of rivers & streams of Indian sub-continent: D.K. Belsare, Narendra Publishing House, New Delhi (2011).
5. Limnological methods: P.S. Welch, Narendra Publishing House, New Delhi (2009).

5. Entrepreneurship Development and Business Management [FSEM 1205] 3(2+1)

Objectives:

1. To familiarize with the concepts of managerial and entrepreneurship with respect to fisheries industry.

2. To understand the fundamentals of business management and organizational behaviour.

3. To gain insights into government schemes and incentives for the promotion of entrepreneurship.

Outcomes:

1. Enhanced knowledge and entrepreneurship mind set.

2. Inculcate entrepreneurial skills and business management competencies.

3. Encourage innovation and idea commercialization in the market sector.

4. Promoting sustainable and profitable agri and allied ventures.

Theory:

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment– identification of product/service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product/services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing knowhow, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise

Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages/salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long-term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical:

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agric entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposals for funding by different agencies

References:

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.

2. Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publl. House. 3. Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.

4. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.

5. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.

6. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.

7. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.

8. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.

9. Singhal R.K., 2013, Entrepreneurship Development and Management, Katson Books.

10. Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.

11. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House

5. Environmental Studies and Disaster Management [ASEC 1202] 3(2+1)

Objectives:

1. To provide a deep understanding of ecosystems and their components.

2. To educate about the importance of conserving biodiversity and various strategies for effective conservation.

3. To equip with the knowledge and skills necessary to assess and manage disaster and

environmental disruptions.

Outcomes:

1. Understand components of ecosystems, and biogeochemical cycles, and analyze the energy flow and trophic interaction within these systems.

2. Identify threats to aquatic ecosystems, and propose conservation measures for protecting biodiversity. Able to assess the vulnerability of ecosystems to disasters, implement preventive measures, and respond effectively to environmental disruptions.

3. Gain knowledge on pre-disaster, during-disaster, and post-disaster management strategies.

4. Familiar with national and international policies and conventions related to ecosystem conservation and disaster management.

5. Familiar with National and International policies related to ecosystem conservation and disaster management

Theory:

Introduction to Environment - Environmental studies - Definition, scope and importance - Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity. Environmental Pollution: Definition, cause, effects and control measures of: (a) Air pollution. (b) Water pollution. (c) Soil pollution. (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution. (h) light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management

Practical:

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to windmill/hydropower / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and unpolluted systems. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem – Visit to pond/river/hills. Visit to areas affected by natural disasters..

References:

1. De. A.K., 2010. Environmental chemistry. Published by New Age International Publishers, New

2. Dhar Chakrabarti. P.G., 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bangalore. 36 pp.

3. Erach Bharucha, Text book for Environmental studies. University Grants Commission, New Delhi

4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi, India 2023. (In Press).

5. Prasanthrajan M, P.P. Mahendran., 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur - 313 002. First Edition: 2008

6. Prasanthrajan M, 2018. Objective environmental studies and disaster management. ISBN 9789387893825. Scientific publishers, Jodhpur, India. Pp. 146.

7. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India 8. Tyler Miller and Scot Spoolman. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

7. Personality Development [ASEE 1204] 2(1+1)

Objectives:

1. To make students realize their potential strengths, cultivate their inter-personal skills and improve employability.
2. To gain insight into their personality traits, strengths, weaknesses, values, and goals.
3. Foster self-confidence through practical exercises, presentations, and constructive feedback.

Outcomes:

1. Effective time management, handling stress, and maintaining work-life balance.

2. Understanding and management of emotions, empathy, and conflict resolution.
3. Students will gain confidence in their abilities and present themselves effectively in diverse scenarios.
4. Ability to express ideas clearly and listen actively, improving interpersonal relationships.
5. Graduates of the course will carry themselves with dignity and professionalism in both personal and workplace settings.

Theory:

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour. Foundations of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical:

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading:

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development. 6th edn. Belmont, CA: Wadsworth.

8. National Cadet Corps (NCC-II) /National Service Scheme (NSS-II) (ASSW 1102] 1(0+1)

Objectives:

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen

2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation

3. Demonstrate a deep sense of loyalty and responsibility toward the nation.

Outcomes:

1. Showcase improved physical fitness, mental resilience, and ethical values.
2. Lead teams effectively, work collaboratively, and make informed decisions.
3. Contribute actively to social welfare projects and address community challenges.
4. Use acquired life skills to assist in disaster relief, first aid, and crisis management.
5. Gain knowledge on NSS/NCC Activities.

Practical:

Arms Drill- Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill. Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding. Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG. Introduction to map, scales, and conventional signs. Topographical forms and technical terms. The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs. Field defences obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Cadet Corps (NCC-II)

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Practical:

Importance and role of youth leadership. Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies. Definition and importance of life competencies, problem-solving and decision-making, interpersonal communication. Youth development programs. Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations. Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

 # Post-II semester

Internship (only for exit option for award of UG-Certificate) 10 (0+10)

Objectives

1. To make students capable of working in commercial establishments with ground-level knowledge

2. To make students capable of initiating entrepreneurship

SKILL BASKET

Aquaculture		
1	Fish/Shellfish Breeding and Hatchery Operation	2(0+2)
2	Fish/Shellfish Seed Rearing	2(0+2)
3	Fish/Shellfish Grow-out Production Management	2(0+2)
4	Breeding and Culture of Ornamental Fish	2(0+2)
5	Integrated Fish Farming	2(0+2)
6	Non-conventional Aquaculture Farming Practices	2(0+2)
7	Fish Feed Production and Marketing	2(0+2)
8	Aquarium Making, Decoration and Management	2(0+2)
Aquatic Environment Management		
9	Analytical Techniques of Aquaculture	2(0+2)
Aquatic Animal Health Management		
10	Laboratory Techniques for Fish Pathogen Detection	2(0+2)
Fish Processing Technology		
11	Preparation and Marketing of Value-Added Products	2(0+2)
12	Preparation of Fish By-Products and Waste Utilization	2(0+2)
13	Fish Handling, Transportation and Preservation	2(0+2)
14	Bio-chemical Analysis of Fish and fisheries products	2(0+2)
Fishing Technology and Engineering		
15	Net Making and Mending	2(0+2)
Fishery Extension, Economics and Statistics		
16	Start-up and Incubation in Fisheries	2(0+2)
17	Data Analysis and Computation	2(0+2)
18	Fish Market Survey and Value Chain Analysis	2(0+2)
Others		
19	Any other relevant to the region, which may be decided by the College	2(0+2)