UNIVERSITY OF KERALA

Prospectus

Online applications are invited from eligible candidates for the Entrance Examination for admission to **M.Phil.,** Degree Programme in **Marine Science and Technology** of one year duration in the **Department of Aquatic Biology and Fisheries** during the academic year 2018-2019.

Applications can be downloaded from
https://admissions.keralauniversity.ac.in/mphil2018/
Last Date for submission of completed application: 31.07.2018
Date of Entrance Examination: 14.8.2018
Completed Application form and Hall Ticket along with pay in slip/demand draft should be submitted to: The Head, Department of Aquatic Biology and Fisheries, Kerala University Campus, Kariavattom, Thiruvananthapuram 695 581, Kerala.

I. Eligibility Criteria for admission to M.Phil DegreeProgrammes in Teaching and Research Departments of University of Kerala

1. Candidates for admission to the M.Phil programmes shall have a Masters degree or a professional degree declared equivalent to the Masters degree by the corresponding statutory regulatory body, with at least 55% marks in aggregate or its equivalent grade 'B' in the UGC 7-point scale (or an equivalent grade in a point scale wherever grading system is followed) or an equivalent degree from a foreign educational institution accredited by an Assessment and Accreditation Agency which is approved, recognized or authorized by an authority, established or incorporated under a law in its home country or any other statutory authority in that country for the purpose of assessing, accrediting or assuring quality and standards of educational institutions.

2. A relaxation of 5% of marks, from 55% to 50%, or an equivalent relaxation in the case of grade, may be allowed for those belonging to SC/ST/OBC (non-creamy layer)/Differently-abled and other categories of candidates as per the decision of the UGC from time to time, or for those who had obtained their Masters degree prior to 19th September, 1991. The eligibility marks of 55% (or an equivalent grade in a point scale wherever grading system is followed) and a relaxation of 5% to the categories mentioned above are permissible based only on the qualifying marks without including the grace mark procedures.

3. Candidates who have written their Post Graduate Degree Examination and awaiting results can also apply. But such candidates should upload their PG marks/ CGPA in form 'B' on or before the last date for uploading form 'B'.

II. M.Phil., Programmes offered by the University Department of Aquatic Biology & Fisheries at Kariavattom along with their eligibility conditions.

Department	Subject	Eligibility
Aquatic Biology & Fisheries	Marine Science and Technology	M.Sc., degree in Marine Science/ Marine Technology, Aquatic Biology and Fisheries/ Marine Biology/ Marine Biotechnology/ Marine Microbiology/ Mariculture/ Marine Biology and Oceanography/ Coastal Aquaculture/ Marine Food Technology/Marine Pharmacology/ Marine Chemistry/ Bioscience/ Zoology/ Environmental Science; M. Tech. in Marine Engineering/ Marine Technology.

As per clause 9.1 of Regulations for the award of M.Phil Degrees, University of Kerala 2016, Post-graduate Departments of affiliated colleges and Research Laboratories of Central/State Government with at least two Ph.D qualified teachers/scientists in the Department concerned along with required infrastructure, supporting administrative and research promotion facilities as per these regulations, stipulated under sub clause 9.2 shall be considered eligible to offer M.Phil Programmes. Therefore M.Phil seats shall be allotted to the Departments of University College subject to the availability of research supervisors and supporting facilities.

III. Number of Seats for each M.Phil Degree programmes.

Number of Seats for each M.Phil programme shall be decided based on the number of research supervisors available in the department. A Professor as Research Supervisor/Co-Supervisor, at any given point of time shall guide not more than three M.Phil scholars. An Associate Professor as Research Supervisor shall guide up to a maximum of two M.Phil scholars and an Assistant Professor as Research Supervisor shall guide only one M.Phil scholar.

IV. Procedure for admission.

1. Admission shall be based on the criteria notified by the University, keeping in view the guidelines/norms in this regard issued by the UGC and University bodies concerned, and taking into account the reservation policy of the State Government/University, applicable to SC/ST/OBC(Non-creamy layer)/ Differently- abled and other categories of candidates, as decided by the State Government/University from time to time.

2. Candidates for M.Phil Degree programmes shall be granted admission through an Entrance Test (3 hour duration) conducted by the University.

3. The number of M.Phil scholars to be admitted to each subject of study at the University Departments/Centres and duly approved Research Centres shall be decided based on the number of available Research Supervisors and other academic as well as physical facilities available, in accordance with the norms regarding the scholar teacher ratio, laboratory, library and such other facilities.

4. Candidates eligible for registration shall be decided by a two stage process – Entrance Examination and Interview.

5. Syllabus of the Entrance Test shall consists of questions based on Research Methodology (50%) and the subject of study concerned (50%).

6. Interview shall be conducted by the Department Doctoral Committee (DDC) in such a way that the candidates would be required to discuss their research interest/area.

7. Weightage for different components shall be as follows.

Sl.No.	Components	Marks (%)
1.	Qualifying Examination	50
2.	Entrance Examination	40
3.	Interview	10

8. The CGPA of applicants who have passed their Qualifying examination from University of Kerala will be converted to marks in percentage using standard process.
9. Applicants who have passed their qualifying Examination from Universities other than Kerala should enter their CGPA after converting into percentage.

10. Weightage for research activities that shall be added to the score in the qualifying examination.

    i. Presentation of paper in the state level conference/seminar (to be approved by the DDC concerned) – 0.3% of scored marks in the qualifying examination.
    ii. Presentation of paper in the national level conference/seminar (to be approved by the DDC concerned) – 0.4% of the scored marks in the qualifying examination.

    iii. Publication of paper in peer reviewed journals published by leading institutions (to be approved by the DDC concerned) – 0.5% of the scored marks in the qualifying examination.

V. Fee for Registration and Mode of Payment.

Sl.No.	Fee Details	General Candidates	SC/ST Candidates
1.	Fee for Registration	Rs.500/-	Rs.250/-
2.	Fee for each Additional Subject applied	Rs.50/-	Rs.25/-

The Registration Fee is to be remitted to KUF account directly in any of the Cash Counters of the University of Kerala or in any branch of State Bank of India in the form of Demand Draft drawn in favour of Finance Officer, University of Kerala.

Note: The Registration fee once remitted will not be refunded under any circumstances.

ADMISSION ACTIVITIES

1. Reporting at the University Department: Candidates need to report for admission before the Head of the Department concerned only when the announcement regarding the same is made by the University. He/she should report with the following documents in original:

(a) The Admission Memo.

(ii) Receipt of University fee remitted in the bank.

(iii) Certificate to prove date of birth.

(iv) Transfer Certificate (T C) from the Institution last attended and Conduct Certificate.

(v) Mark lists of the PG Degree examination and Provisional/PG Degree Certificate.

(vi) Eligibility Certificate from University of Kerala, in case of candidates who have passed their qualifying examination from other Universities.

(vii) Migration Certificate in case of candidates who have passed their qualifying examination from other Universities.

(viii) Any other documents required to be produced by the Head of Institution.

3. **Verification of Documents:** The Head of the Department shall be responsible for verification of original documents and satisfaction of the correctness of the records produced by the candidate at the time of admission. The Head of the Department will have the right to deny an admission, if he/she finds any relevant mismatch in the original documents and online data that has affected the ranking process.

4. **Failure to report for Admission:** Candidates who do not take admission on the prescribed date and time in the University Department will lose his/her claim for admissions.

5. **Fee to be paid to the University on admission:** At the time of admission, the candidate has to remit the requisite fee in the University department. The Details of fee will be provided in the admission memo.

6. Candidates belonging to SC/ST communities allotted against merit seats or against the seats reserved for them are exempted from payment of fee.

7. Claim for fee concession to OEC candidates: Candidates belonging to Other Eligible Communities (OEC) are exempted from payment of fee at the time of admission to M.Phil programmes, irrespective of annual family income as per G.O. (MS) No. 36/07/SCSTDD, dated: 03.07.2007. They should provide Community Certificate from the Village Officer along with the acknowledgement.

7. SC/ST/OEC candidates will have to pay the "Caution Deposit" as per rules.

VI. OTHER ITEMS

1. The whole process of admission to the M.Phil Degree programmes 2018-19 will be done by the University of Kerala, as per provisions of the regulation for award of M.Phil Degrees, University of Kerala (2016).

2. The University of Kerala will not entertain any request for change of any date fixed for the Admission from time to time.

3. All disputes pertaining to the allotment for admission shall fall within the jurisdiction of the Hon'ble High Court of Kerala.

4. Any other items not specifically covered in this Prospectus will be decided by the University of Kerala and the decision shall be final.

University Buildings,
Thiruvananthapuram **REGISTRAR**

UNIVERSITY OF KERALA

Re-accredited with A-Grade by NAAC

ADMISSION FOR M.PHIL DEGREE COURSE 2018-19

Marine Science and Technology

COMPLETED APPLICATION FORM

PERSONAL DETAILS			
Application No.		Affix self-attested Passport size photo	
Name of Applicant			
Date of Birth			
Gener			
Nationality			
Address for Communication		**Permanent Address**	
Land Phone		Mobile	
Email		Annual Income of Parent	
Place of birth		Age	
Whether employed		Marital Status	
RESERVATION DETAILS			
Whether Creamy Layer			
Religion		Category	
Caste		Whether OEC	
Whether PWD		Whether BPL	

MISCELLANEOUS DETAILS			
Do you have any scholarship or Fee concession:			
Do you have presentation in state level conference /Seminar (to be approved by DDC Concerned)			Yes/No
Do you have presentation in National level Conference/Seminar (to be approved by DDC Concerned)			Yes/No
Do you have paper publication in peer reviewed journals published by leading institutions (to be approved by DDC Concerned)			Yes/No
Any other Qualification:			
QUALIFYING DEGREE DETAILS			
Name of University			
Year of Passing		Pattern of Examination Passed	
Qualifying Degree		Class of the Qualifying Degree	
Qualifying Degree CGPA		Qualifying Degree Percentage of Marks	
REGISTRATION FEE DETAILS			
Fee Category			
Receipt No Date		DD No. Date	
Amount			
DECLARATION			
I accept that all the information given in the application is true to the best of my knowledge. And I also understand that any information which later found to incorrect may forfeit my prospects to take admission under the University of Kerala. I undertake that I shall abide by the rules and regulations of the University. Signature			

UNIVERSITY OF KERALA

(Re-accredited by NAAC with 'A' Grade)

Department of Aquatic Biology and Fisheries
Kerala University Campus, Kariavattom, Thiruvananthapuram. 695581

HALL TICKET FOR M.Phil. ENTRANCE EXAMINATION 2018

(Subject, Name and Address to be filled in by Candidate)

Register Number :

.....

*** Signature of Candidate**

Passport size Photo of the Candidate to be attested by a Gazetted Officer.

Name :

Address :

Subject :

Signature of the Gazetted Officer with date and Designation

* To be signed in the presence of the attesting Officer.

UNIVERSITY OF KERALA

DEPARTMENT OF AQUATIC BIOLOGY AND FISHERIES

M. Phil. Marine Science and Technology

ENTRANCE EXAMINATION- SYLLABUS

Part: A

Unit 1. Marine Biology and Oceanography

Intertidal ecology: Environmental factors. Adaptations. Intertidal community – Rocky, Sandy, Muddy shores: Environmental factors, Zonation, Feeding Biology, Community structure, Trophic structure. Tide pools.

Plankton: Classification. Methods of sampling, preservation, analysis and estimation of Biomass. Productivity. Phytoplankton-Zooplankton relationship. Indicator species. Plankton and fisheries.

Estuaries. Classification. Characteristics. Estuarine Biology. Estuaries and backwaters in India

Mangrove ecosystems: Distribution. Structure and adaptations. Environmental condition. Zonations. Fauna. Major mangrove ecosystems in India. Conservation.

Coral reefs: Origin. Global Reef distribution. Status of coral reefs. Environmental factors. Structure of corals. Reef zonation and composition. Biology of hermatypic corals. Octocorals. Species infraction. Reef conservation.

Deep Sea Biology: Environmental characteristics. Adaptations. Sampling strategy. Midwater community. Ecology. Zonation. Hydrothermal vents.

Harmful Algal blooms: Harmful Algae. Ecology of Algal Bloom. Monitoring Algal Bloom. Seafood poisoning. Management and Mitigation.

Marine Biodiversity: Status of Global Marine Biodiversity. Gradients of Marine Biodiversity. Census of Marine Life. Status of Marine Biodiversity in India. Threats. Protected areas. Marine Biosphere Reserves.

Properties of sea water: Temperature. Salinity. Density. Light. Pressure. Colour. Surface tension and viscosity. Sound. Distribution of Temperature, salinity and density. Heat budget.

Ocean circulation: Wind-driven currents. Ekman Motion. Geostrophic Currents. Surface ocean circulation. Upwelling and Downwelling. Eddies. Inertial currents. Longmuir circulation. Thermohaline circulation. Deep ocean circulation. Tracers, TS diagram. OTEC.

Waves: Characteristics. Classification. Forces. Wave refraction. Breakers. Tsunami. Seiches. Internal wave. Storm surges, Wave energy. Tides: Generating forces. Equilibrium theory. Dynamic theory. Characteristics. Tides and marine organisms. Power generation.

Mud banks of Kerala coast: Classification. Terminology. History. Locations. Natural Environmental factors. Theories.

Marine Pollution: Definition. Categories of Pollution – Oil, Heavy Metals, Pesticides, Sewage, Radionuclides, Thermal, Synthetic organic chemicals. Antifouling paints. Plastics and Trash. Toxicity. Costs of pollution.

Unit 2. Taxonomy and Biodiversity

Systematics and Taxonomy. Taxonomy and its importance. Taxonomic Impediment. Global Taxonomy Initiative. Taxa and species concepts. Phylogenetic groups: monophyly, polyphyly and paraphyly. Cladistics. Cladogram. Parsimony.

Taxonomic characters. Identification using keys. Dichotomous key. Types of Keys: Simple dichotomous, Bracket, Indented, Serial, Branching, Circular, Box, Pictorial keys. Single access and multi-access keys. Key construction. Computerized Key Construction.

New approaches in taxonomy: Numerical, Phenetic, Cladistic and Molecular. Molecular markers – PCR, RAPD, RFLP, microsatellites, mini satellites and Mitochondrial DNA, and their application in fish phylogenetic studies.

International Code for Zoological Nomenclature. Principle of Binominal Nomenclature, Principle of Priority, Principle of Coordination, Principle of the First Reviser, Principle of Homonymy, Principle of Typification. Nomen dubium, nomen nudum, nomen oblitum. The law of priority. Kinds of types.

Taxonomic publications. Preparation of taxonomic papers. Integrated Taxonomic Information System. World Register of Marine Species, Encyclopedia of Life, Catalogue of Life (CoL), Species 2000, Wikispecies, Archive, Macroscopic Observatory, Global Biodiversity Information Facility (GBIF), FishBase

Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity. Alpha, Beta and Gama diversity. Consumptive use, productive use, social, ethical, aesthetic and option values of biodiversity.

Levels and Measures of Biodiversity. Biodiversity at global, National and local levels. Mega Biodiversity Countries. Concept of endemism. Biodiversity hotspots of the world. Western Ghats Biodiversity Hotspot. Aquatic Biodiversity of the Western Ghats.

Threats to biodiversity. Habitat loss and fragmentation, over exploitation, pollution, invasive alien species, climate change. Problem of Genetic diversity loss over time : Bottlenecks, Genetic drifts, Inbreeding depression. Extinction vortex. Sixth extinction. RET species. IUCN classification of threatened species. Red Data Book. Biodiversity conservation strategies. Endangered and endemic species of India. Indian efforts for biodiversity conservation.

Convention on Biological Diversity. Biological Diversity Act and Rules of India. Biodiversity and biopiracy. Biodiversity Target. Aichi Target. UN Decade on Biodiversity.

Unit 3. Fish Biology

Natural history and diversity of fishes. General classification of fishes. Classification of selected orders. Morphology and anatomy: Body forms, fins, scales, colouration. Meristic and morphometric studies; truss morphometry.

Digestive system. Food and feeding: Natural fish food. Types of feeding. Structural modifications in relation to feeding habit. Fullness of stomach and feeding intensity. Relative gut length. Gut content analysis.

Air bladders in fishes. Weberian ossicles. Gas exchange, blood and circulatory system. Excretory system. Endocrine system. Nervous system and sense organs. Osmoregulation and ion balance. Electric organs and luminous organs.

Reproductive system. Sex determination. Maturity stages and preparation of maturity keys. Maturity index. Ova diameter study. Estimation of fecundity. Life histories of fish.

Age and growth: Principles of age determination. Scale method. Otolith method. Other skeletal parts as age indicators. Length-frequency method.

Biology of Crustacea: General organization of decapod crustaceans, with special emphasis on crabs, prawns and lobsters. Morphology and anatomy of crabs, prawns and lobsters. Digestive system of crabs and shrimps. Feeding and breeding biology of shrimps. Larval development in crabs, prawns and lobsters.

Biology of Mollusca: General organization of Mollusca. Morphology and anatomy of bivalves, gastropods and cephalopods. Digestive system of gastropods and bivalves. Feeding and breeding biology of molluscs. Larval development of bivalves, gastropods and cephalopods.

Unit 4. Fish Physiology

Swimming and buoyancy in fishes. Muscle physiology: body waves, energetics. Physiological aspects of dynamic and static lift. Mechanism of gas exchange in air bladder.

Food and feeding biology: Components of balanced food, Ingestion of food and feeding mechanism. Digestive system and glands. Physiology of Digestion: Digestion of carbohydrates, lipid and proteins. Digestive enzymes and regulation of their secretions, Absorption and assimilation of nutrients, Role of hormones in the regulation of digestion, Factors affecting digestion and transport of nutrients.

Physiology of respiration, mechanism of gas exchange. Branchial pump. Gill ventilation. Composition of fish blood and respiratory pigments. Aerial respiration. Ammonia quotient, Chloride cells and role in respiration, Respiratory metabolism, energy budget.

Osmoregulation and ion balance: salt balance in marine and freshwater fishes. Chloride cells. Osmoregulation in elasmobranchs. Excretory organs in fish and shell fish and their function, urea cycle, endocrine control of osmoregulation.

Sense organs in fishes: lateral line system, acoustic system, vision, electro-receptors, electric organs. Physical nature and chemical basis of bioluminescence, chromatophores, sense organs in shell fish.

Sexual dimorphism, primary and secondary sex characters, bisexual reproduction, inter-exes, hermaphroditism, Sex differentiation and factors affecting sex differentiation. Sex reversal in fish, factors affecting sex reversal. Development of gonad, oogenesis; spermatogenesis, metabolic changes during oogenesis and spermatogenesis, vitellogenesis and gonadal steroidogenesis. Annual reproductive cycle and breeding patterns in male and female.

Pheromones and reproductive behaviour, parental care. Regulation of seasonal reproduction: Role of environment (photoperiod, temperature, rainfall), Role of hypothalamo-hypophyseal system and pineal gland, role of peripheral endocrine system, role of nutrition.

Unit 5. Cell and Molecular Biology and Bioinformatics

DNA, Polymorphic DNAs and RNAs. Replication of DNA. Enzymes involved in DNA replication. Unscheduled DNA.

Regulation of cell division in normal cell and malignant cells. Molecular change in DNA associated with cell cycle. Control of cell cycle. Control of sequence events. External and internal mitotic inducers. Cell death.

Genetic engineering. Cloning. Major steps in gene cloning. Sources and isolation of gene: Shotgun method. Reverse transcriptase method. Synthetic gene. Genomic and DNA library. Vectors: Properties of ideal vector. Plasmids: Isolation and kinds. Cutting and joining of DNA. Restriction endonucleases: Types. Ligation. DNA probes. DNA finger printing. Homopolymer tailing, linkers and adapters. Host cells. Gene transfer techniques: Calcium chloride transformation. Calcium phosphate coprecipitation. DEAE. Dextron. Electro-poration. Protoplast fusion. Microinjection. Lipofection. Retrovirus.

Animal cell culture: Primary culture, cell lines. Media culture systems. Fish cell lines. Hybridoma technology. Diagnosis of genetic disorders. DNA probes. Gene therapy (brief account).

Nature and scope of bioinformatics. Bioinformatics versus computational biology. Branches of bioinformatics. Basic concepts. Computational genomics and proteomics. DNA sequence data formats. Sequence alignment algorithms. Scoring matrices (PAM and BWSUM). BLAST software. Molecular visualization software. Basic amino acid sequence.

Computational phytogenetics – various approaches. Phylip software. Microarray bioinformatics – Experimental design and overview of data analysis. Basic concepts of systems biology. Overview of computer-aided drug design

Unit 6. Biochemistry and Marine Biotechnology

General characteristics of hormones. Chemistry and function of growth and reproductive hormones in fish and shellfish.

Marine Toxins: Toxins from Cyanobacteria, Dinoflagellates, Macroalgae, Cnidarians, Annelids, Molluscs. Molecular mechanisms.

Marine Biomaterials. Biominerals. Biocomposites. Non-mineralized structures. Biopolymers

Marine Nutraceuticals: Marine Microbes. Algal products. Chitin-Chitosan. Collagens. Omega-3 Polyunsaturated fatty acids. Atioxidants. Biological and Biomedical Applications.

Drugs from the Sea: Antibiotics. Anticancer compounds. Antimalarials. Analgesics. Immunomodulators. Cosmaceuticals.

Microbes as tools in marine biotechnology. Marine bacteria. Screening of marine bacteria for metabolites. Biopolymers. Bioremediation, Genetically modified microbes in bioremediation. Marine nanotechnology. Biofuels from Algae.

Genetic Engineering: Introduction of Genomics; Recognition of coding and non-coding regions and annotation of genes; Tools for genome analysis –RFLP, DNA fingerprinting, RAPD, PCR and Automated DNA sequencing.

Genome Sequencing: Genome sequencing – Microbes, plants and animals; Taxonomic classification of organisms using molecular markers – 16S rRNA typing/sequencing; Phylogenetics; Toxicogenomics; Pharmacogenomics and metagenomics.

Animal cell culture: Primary culture, cell lines. Media culture systems. Fish cell lines. Hybridoma technology. Diagnosis of genetic disorders. DNA probes. Gene therapy (brief account).

Unit 7. Genetics

Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance.

Concept of gene: Allele, multiple alleles, complementation tests. Sex determination in fish. Chromosome manipulation: Ploidy induction, sex reversal, gynogenesis and androgenesis. Cryopreservation.

Genetic variation: Causes and measurement; Chromosome theory of inheritance: genetic basis of determination of sex.

Modern concept of gene; DNA as genetic material, genetic code and protein synthesis, transfer and regulation of genetic information.

Pleiotropy; Penetrance; Gene and genotypic frequency and factors affecting them. Population genetics, Hardy Weinberg Equillibrium. Application of selection for performance improvement. Inbreeding. Genetic drift.

Mutation: natural and induced, mutagens fate of mutant allele in the population; Cross breeding and genetic drift.

Unit 8. Marine Fisheries

Introduction to marine fisheries of the world. Major fishing zones of world and India. Trends in fish production. Introduction to marine fisheries of India. Pelagic and demersal fishery resources of India. Marine capture fishery of Kerala. Mud bank fishery- wedge bank fishery.

Pelagic fisheries of India: sardines, mackerels, anchovies, white baits, tuna, seer fish, carangids, ribbonfish, shads and other clupeids, barracudas, Bombay duck, pomfrets, mullets. Features and trends in the production of pelagic fisheries. Conservation of pelagic fish stocks.

Demersal fisheries of India: sharks, major perches, threadfin, breams, sciaenids, silver belly. Features and trends in production of demersal fisheries. Impact of trawling. Conservation of demersal fish stocks.

History of deep sea fishing. Oceanic and deep sea fisheries of India. Potential resources. Deep scattering layer fish biomass. Deep sea fishing policy of India.

Crustacean fishery of India: Penaeid and non-penaeid shrimp fisheries. Stock assessment and management options. Lobster fishery. Crab fishery.

Molluscan fishery of India: Mussel fishery. Clam fishery. Cephalopod fishery. chank fishery.

Principles of fish population dynamics: Recruitment. Growth. Mortality. Catch per unit effort. Population studies and stock assessments: Population structure: Age-length and sex composition. Estimation of population size. Marking and tagging. Population dynamics. Population models. Stability of exploited population – Maximum Sustainable Yield. Assessment of fish stocks.

Unit 9. Coastal Aquaculture and Mariculture

Overview of status of coastal aquaculture and mariculture- global and Indian perspective; scope, potential and emerging trends. Different farming systems, Traditional, extensive, modified extensive, semi intensive and intensive. Satellite farming. Culture of marine fin and shell fishes. Distribution and biology of culturable species. Principles of coastal aquaculture and mariculture. Aquaranching.

Site selection, design and project preparation for the establishment of a shrimp hatchery. Culture of shrimps: stocking, water quality, feeding, health management, harvesting. Selection of site and selection of materials for pen/cage culture. Important fishes cultured in the open seas and culture systems.

Seed production and culture of brackishwater fishes pearl spot, sea bream, groupers, yellow tail, eel, cobia, pompano. Shrimp seed production: brood stock maintenance, larval stages, feeding, water quality requirements, health management, packing and transportation, design of shrimp hatchery.

Seed production and culture of crabs and lobsters. Seed production and culture of mussels, oysters and clams. Pearl production. Culture of sea cucumbers. Seed production technology. Culture of sea urchins. Species diversification in aquaculture. Positive and negative impacts of introduced species

Unit 10. Fishing Technology and Sustainable Fisheries Management

ISSCFG classification of fishing gears. Detailed account.

Design, fabrication and operation of major fishing gears in India: trawls, purse seines, gill nets, trammel nets, dol nets.

Important fishing boats of India; classification.

Sea safety equipment, communication devices, navigational devices, fish finding equipment.

Bycatch reduction methods; prohibited fishing practices; turtle excluder device; Vessel monitoring system (VMS); catch certification. CCRF Article 8: Fishing operations

Unit 11. Fish Processing Technology

Importance of fish in human diet. Nutritional quality of Fish. Proximate composition of fish. Spoilage of fish, Rigor mortis.

Drying: Basic principles, natural drying packing and storage of dried fish. Salting: principles, quality of salt, Kench salting, brine sailing. Smoking: Principles of smoking, cold smoking, hot smoking, fuel, packing and storage of smoked fish. Chilling: Manufacture and storage of ice, quality of ice, methods of chilling. Freezing: Basic principles, methods and application of chilling, Block freezing, Individual quick freezing (IQF), storage of chilled and frozen fish. Thermal processing. Canning. Other methods of processing and preservation. Spoilage in preserved seafood.

Fundamental aspects of quality control in sea food. Inspection of sea food quality. Different aspects of sea food quality. National agencies for sea food inspection. HACCP. Hygiene in processing plants.

Bacteriology of fish and shellfish. Spoilage Bacteria. Bacteria of human health significance in seafood.

Unit 12. Marine Engineering:

Seamen & their duties, Safety and Cargo Work, Navigational Lights and Signals, Navigation. Abandoning ship, Survival at sea, Life Saving Appliances, MARPOL Convention, SOLAS, STCW conventions, ISPS code and other maritime codes and conventions.

Various terms used in ship construction, Stresses in Ship's Structure, Framing systems and Double Bottom, Shell & Decks, Bulk heads & Deep Tanks, Ship Types, Piping and venting Systems, Offshore Technology, Ship Surveys.

Framing systems and Double Bottom, Shell & Decks, Bulk heads & Deep Tanks, Ship Types, Piping and venting Systems, Offshore Technology, Ship Surveys.

The second Law of Thermodynamics, Steam cycle, Steam Engines, Reciprocating Compressor, Direct current machines, Transformers, Friction, Dynamics of Rotation, Periodic Motion, Drives and Brake, Strain Energy in Simple Stresses, Shear & Torsion, Corrosion and its prevention, Selection of Materials in Shipbuilding & Marine Engineering, Fuels, Combustion & Dissociation, Steam Turbines, Basics & Buoyancy.

Geometry of Ship & Hydrostatic Calculations, Transverse Stability of Ships, Steering gears, Shafting, Dry Docking, Shipboard application of hydraulic system, Motion of Ship on waves, Strength of Ships, Propulsion & Propellers, Marine Environment .

Part: B

Research Methodology:

Definitions: Research - purpose, relevance and scope; Motivation and inspiration for research; various outlooks on research; Types of Research. Steps involved in research process; Identifying and defining researchable problems. Literature review - primary and secondary sources, web resources; Google scholar, Science Direct and Scopus; Bibliometrics and webmetrics; Important Databases for Fish & Aquatic Sciences. Identifying gap areas from literature review; Formulation of research objectives; Hypothesis. Research designs. Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

Method of Scientific Investigation - Observation, planning and collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies – Interpretation and Generalization – Measures of central tendency and variation, Probability and Probability distribution, Correlation and Regression, Test of Hypothesis (Chi Test, Student t test, ANOVA) - Introduction to statistical software (SPSS, PRIMER, Statistica, 'R') - Bioinformatics tools.

Types of research papers - Research Article, research communication, scientific correspondence, general research article, review article, opinion, letters; Format of thesis. IMARD format, preparation of bibliography. Formats of a research paper- - objectives of each section- reference writing styles; Proof reading and editing; Authorship; Collaborative authoring tools; Publication process- Peer review- single/double blind and open; Institutional repositories and Open Access Publications. Impact factors, citation index, h, 'h-bar' and g indices; Pitfalls in interpreting impact. Reference management tools: diigo, zotero, mind manager, endnote; Academic search engine optimisation: Current Awareness: RSS feeds, TOC alerts. Planning Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication. Preparation of posters. Guidelines for effective multi-media and poster presentations.

IPR awareness: Copyrights and patents; Brief overview of IPR and IPR laws in India. Brief overview of GATT, TRIPS; India as knowledge Power. e-Shodh-Sindhu Consortium.

Research Ethics; software for checking plagiarism- URKUND. Guidelines for using animals in biological research - The Prevention of Cruelty to Animals Act, India.

Eligibility:

M.Sc., degree in Marine Science, Marine Technology, Aquatic Biology and Fisheries, Marine Biology, Marine Biotechnology, Marine Microbiology, Mariculture, Marine Biology and Oceanography, Coastal Aquaculture, Marine Food Technology, Marine Pharmacology, Marine Chemistry, Bioscience, Zoology, Environmental Science, **M. Tech.,** in Marine Engineering or Marine Technology.