SYLLABUS

For

M.Sc. (Aquatic Biology)

Semester I to IV

2020-21

Submitted by
Department of Aquatic Biology
Veer Narmad South Gujarat University
Surat-395007

Master of Aquatic Biology

Name of Program	Master of AquaticBiology
Abbreviation	**AQB**
Duration	**2 Years (Four Semester)**
Eligibility Criteria	A candidate who has obtained his/her bachelor's degreein science except maths and physics.
Objective of Program	The main objective of the programme is to prepare the students for productive career in Aquatic resources management and sustainable utilization of aquatic resources by providing an outstanding environment of teaching and research in the specific aspects of the designed program. This structured course will facilitate a career in various institutions such as research and development centers of private limited, public companies, Aquaculture sectors, farms, fisheries department etc.
Program Outcome	**PO1 : Basic Knowledge Enhancement** The designed Program enhances students with the basic knowledge of the subject matter in order to capable students develop research skills which include laboratory techniques, aqua farm field techniques, disease management in aquaculture sector, feed technology, biochemistry, microbiological assessment, fish genetics , biotechnology and bioinformatics, aquarium setup, ornamental fisheries, marine and freshwater fisheries and Planktonology. **PO2 : Skill Development** The program develops the skills of managing aquatic resources and use of techniques and instruments to develop remedies to manage aquatic resources. **PO3 : Familiar with Advanced Emerging Technologies** The program trains students with the latest technologies that is being used in the aquaculture sectors and aquatic pollution management. The designed syllabi enrich students with the technical aspects to identify aquatic problems in the natural environment. **PO4 : Skill in analysis technique with Extension Education** The program capable students for analysis ,conceptualizing the real-world problems. It also enables students understand the Regulation and Development in managing aquatic sources. **PO5 : Research and Project Development** Development of factual project provides the learner's exposure to work in the demanding environment of the industry. The research and project development skillprepares students for employable and industry ready environment. **PO6 : Group discussion, field visits, presentationand confidence Development** The designed syllabi enablestudents be capable of group discussion, sharing ideas and views. This enables to develop confidence among the students. Healthy discussion in recent technology and legislations, pollution amendments and fisheries Technology enables acquaintances of the students with the practical aspects.
Program Specific Outcomes	PSO1 : Develop and strengthen the basic knowledge and concepts that are required to manage aquatic resources.

	PSO2 : Develop the professional and entrepreneurship skills to be confident in the practical aspects. PSO3 :Raising the students capable for handling instruments and use of latest technology to find remedial measures with respect to fisheries and pollution. PSO4 : Develop students for self-learning and challenging situation in aquaculture sectorsand extension education. PSO5 :Enable students to use recent technologies for analyzing the research and practical concepts. PSO6 :Development for continuous learning and research for successful academic and industrial career.

Mapping between POs and PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1						
PO2						
PO3						
PO4						
PO5						
PO6						

Medium of Instruction	English					
Programme structure	Semester-I					
Theory Paper /Practical	Teaching schedule Hrs /week	Exam Schedule			Total marks	Credit
		Duration (hrs)	Internal marks	External marks		
Theory papers :						
AQB:101 : Aquatic resources and their management	4	3	30	70	100	4
AQB:102 : Instrumentation	4	3	30	70	100	4
AQB:103 : Aquatic Microbiology & Fish Etiology	4	3	30	70	100	4
AQB:104 : Planktonology	4	3	30	70	100	4
Practicals :						
AQB:105: Water & sediment analysis and Instrumentation	4	5	30	70	100	4
AQB:106: Planktonology and Microbiology	4	5	30	70	100	4
		Total	180	420	600	
Programme structure	Semester-II					
Theory Paper /Practical	Teaching schedule Hrs/week	Exam Schedule			Total marks	Credit
		Duration (hrs)	Internal marks	External marks		
Theory papers :						
AQB: 201 : Fish Nutrition, Biochemistry and Feed Technology	4	3	30	70	100	4
AQB: 202 : Fish Genetics and Biotechnology	4	3	30	70	100	4
AQB: 203 : Aquatic	4	3	30	70	100	4

Pollution and Toxicology						
AQB: 204 : Biostatistics, Extension Education and Fisheries legislation	4	3	30	70	100	4
Practical:						
AQB: 205 : Biochemistry, Genetics and Biotechnology	4	5	30	70	100	4
AQB: 206 : Aquatic Pollution & Biostastics	4	5	30	70	100	4
		Total	180	420	600	
Programme structure	Semester-III					
Theory Paper /Practical	Teaching schedule Hrs/week	Exam Schedule			Total marks	Credit
		Duration (Hrs.)	Internal marks	External marks		
Theory papers :						
AQB: 301 – Fish Physiology, Endocrinology & Disease Management	4	3	30	70	100	4
AQB:302 **–** Fisheries Technology	4	3	30	70	100	4
AQB: 303 – Freshwater Aquaculture	4	3	30	70	100	4
AQB: 304 – Marine water Aquaculture	4	3	30	70	100	4
Practicals :						
AQB: 305 – Fish Physiology, Etiology and Fisheries Technology	4	5	30	70	100	4
AQB: 306 –Aquaculture management	4	5	30	70	100	4
		Total	180	420	600	

Programme structure	Semester-IV			
Theory Paper /Practical	Exam Schedule		Total marks	Credit
	Internal marks	External marks		
AQB: 401- Dissertation (Research Work)	45	105	150	6
AQB: 402 - Seminar	45	105	150	6
AQB: 403 - Project formulation for aquaculture Certification and licensing for aquaculture	45	105	150	6
AQB: 404 - Study Tour / Project Work	45	105	150	6
Total	180	420	600	24

Semester I

<table>
<tr><td>Course Code</td><td>101</td></tr>
<tr><td>Course Title</td><td>Aquatic Resources and their Management</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The main purpose of the course is to make students acquainted with concepts of different types ofaquatic resources and the way to manage them.</td></tr>
<tr><td>Course Objective</td><td>The objective of the course is to make the student capable of understanding the types of aquatic ecosystems and aquatic resources along with the measures for their management.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Explain about Inland Ecosystems and Marine ecosystem to strengthen and develop the basic concepts to handle challenging situations in aquaculture sectors
CO2: Explain the types of important Aquatic resources found in the water bodies so as to develop theoretical aspect to be applied in practical situations
CO3: Explain status of Ornamental fish trading in India, their transportation and management
CO4: Explain the setting, design and construction of Aquaria to develop professional skill as well as ways to improvethe condition of aquaria and fishes.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td>Basics of biology and chemistry</td></tr>
<tr><td>Course Content</td><td>Unit – I
➢ Inland Ecosystem and their management:
Origin, classification and distribution of rivers, lakes and ponds, Major river system of India, management of pond, Lake, River. Thermal stratification & thermal exchange in lakes. Classification and distribution of reservoir, transitional phases of reservoir. Management of Reservoirs, Classification, morphology and distribution of estuaries, Lagoons and Coastal inlets, Management of Estuaries
Unit - II
➢ Marine ecosystem:
Origin of ocean floor, classification of marine ecosystem, seas bottom topography: Abyssal, canyons, trenches, main physical (density, viscosity, surface tension, temperature) and chemical (major and minor constituents) properties of sea water Tides, currents and waves, their effects in estuaries and coastal area</td></tr>
</table>

	Unit - III ➢ Aquatic resources: Shell fishes: Prawn, shrimp and molluscs Fin fishes: major carps, catfishes, hilsa, mullet, sardine, mackerel, sport fishes. Aquatic plants: freshwater higher vascular plants, sea weeds, sea grasses and mangroves Unit – IV ➢ Ornamental fish: Status of Ornamental fish trading in India, Design and construction of Aquaria, setting up and management of aquarium Equipment used in aquaria (Biological filters, aerators, heaters etc.), Transportation of ornamental fishes
Reference Books	1. Bames R.S.K. (1999). Introduction to Marine Ecology, Blackwell Science. 2. Edmondson, W.T. (1976). Freshwater Biology 2nd Ed. John Wiley (Ed) and Sons Inc. 3. Golterman, H.L., Clyno, R.S. and Ohnstad, M.A.M. (1978). Methods for physical and chemical analysis of freshwater.2nd Ed. IBP Handbook no.8 Blackwell scientific publication. 4. Grasshoff, K. Enrhardt, M. and Kreenling, K.(1983). Methods of seawater analysisi.2nd Ed. Verlag Chemical 5. Hutchinson, G.E. (1976). A Treatise on limnology. Vol. I & II John Wiley & sons. 6. effery S. Levinton (2000). Marine Ecology, Biodiversity and Function. Oxford. 7. Jhingaran, V.G. (1985). Fish and Fisheries of India. Hindustan publication Corp., New Delhi. 8. Lecren, E.D. and Lowe-Mac Connel, R.H. (1980). The functioning of freshwater ecosystem. Cambridge University Press. 9. Nair,B. N. and Thampy D.M. (1980). A text Book of Marine Ecology. 10. Nybakaken, J.W. (2001). Marine Biology an Ecological Approach 4th edition. 11. Perkins, E.J. (1980). The Biology of Estuaries and coastal water. Academic Press, London.
Teaching Methodology	Classwork, Discussion, Self-Study, models and Assignment
Evaluation Method	30% Internal assessment based on class attendance, assignments, internal examination, etc. 70% External based on University examination

Course Code	AQB:102
Course Title	Instrumentation
Credit	4
Teaching per week	4
Minimum weeks per semester	16
Effective from	June 2020
Purpose of course	The purpose of the course is to develop the operation skill of the

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<tr><td></td><td>instrument that help to analysis of the different physical, chemical and biological parameters.</td></tr>
<tr><td>Course Objective</td><td>To create the awareness and apprise the instrument operation among the students.</td></tr>
<tr><td>Course Outcome</td><td>CO1. Aware and trained the students for safe work procedure and handling of the instruments in the laboratory.
CO2. Elucidate principle of instruments that help to students to understand the instrument and analysis process.
CO3. The students are proficient to use the advances technology and instruments to speed up the analysis process and error free results.
CO4. The working procedure of instruments are elaborated in details that would be able to learn about the application of different instruments in the field of Aquatic Biology.
CO5. Care and maintenance of the laboratory instruments explained in the class help to longer uses of the instruments.</td></tr>
<tr><td>Mapping of COs with PSOs</td><td>
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<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Course prerequisite</td><td>Microscopes, Centrifuge machine, Electrophoretic and water analyser unit</td></tr>
<tr><td></td><td>Unit I (Hrs. 10) Microscopy:
Principle and construction of Microscopes, Types of microscopes- Simple microscope, compound microscope (Student’s microscope, Stereoscopic microscope, Phase contrast microscope, fluorescence microscope and interference microscope) and Electron microscope
Unit II (Hrs. 10) Photometry:
Principle and application of turbidometer. Introduction, Principle and application of Colorometer, Spectrophotometer, (Single bean & double beam), infrared spectroscope, NMR and Mass spectrometer
Unit III(Hrs. 08) Centrifugation and density gradients:
Separation method. Centrifuge: Introduction, construction components and types of centrifuge, Introduction, principle and types of centrifugation(Differential centrifugation and Density gradient centrifugation)
Unit IV (Hrs 17)
(A) Chromatography & Electrophoretic techniques:
Principle of chromatography, Types of chromatography
Protein electrophoresis: SDS, PAGE, Western blotting
(B) Water quality analysers:
Conductivity meter , pH meter,Salino meter, DO meter,COD reflaxor (close and open) and BOD analyser</td></tr>
<tr><td>References</td><td>1. Brown, S.B (1980). An introduction to spectroscopy for Biochemists, Academicpress, London, New York.</td></tr>
</table>

	2. E.D.P. Robertis and E.M.F. Robertis (2001). Cell and Molecular Biology, Lippincott Williams & Wilkins, London 3. Hawcroft, D.M. (1996). Electrophoresis. The Basics IRL press, Oxford. 4. Jenning, W.G. (1993). Analytical Gas chromatography. Academic Press. New York. 5. Skoogs, H, P.andNieman, M (2006). Principle of Instrumental analysis. Thomson Inc. Ltd.
Teaching methods	Chalk and talk, Discussion, Videos, Self-study, Seminars and Assignments
Evaluation methods	Internal assessment (30%) based on the internal exam, attendance and assignments. External assessment (70%) based on the university examination at the end of the semester.

Course Code	**103**
Course Title	**Aquatic Microbiology and Fish Etiology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to make the student able of implementing the concepts and techniques of Aquatic microbiology and develop the skill to identify fish diseases and its associated organisms as well as to find out its remedies.
Course Objective	To make students familiar about microorganisms associated with aquatic environment and its role in biogeochemical cycle, different methods of studying microorganisms, etiology and therapy of fish diseases and quality control of fish.
Course Outcomes	CO1 :Students will able to gain knowledge about type of microorganisms with biogeochemical cycle to understand their role in aquatic environment. CO2 :The counting and identification techniques like SPC, MPN and Qualitative methodshelp to determine the importance and safety level of microorganismsin concern toaquatic production and environment. CO3 :This paper gives idea regarding physical, chemical and physiological defence mechanisms in fishes, diagnostic tools like histopathological methods, PCR, ELISA and therapy of fish diseases which helps students to recognize the causes of diseases as well as prophylactic and therapeutic treatment. CO4 : Explain and train students to deal with post mortem changes of fish, fish pathogens and their prevention and control, microbial quality control of fishery products and HACCP to reduce contamination in fish as well as improving safety of fishery products.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

	CO3						
	CO4						
Pre-requisite	Basics of Microbiology and fish etiology						
Course Content	**Unit – I** **Microorganisms associated with aquatic ecosystem:** General classification of microbes: conventional and modern methods, Microbial communities in Aquatic Environment. General structure and characteristics of microbes (bacteria, fungi, algae and virus), microbes and its role in environmental changes. **Role of microbes in biogeochemical cycles:** Carbon, Nitrogen, Phosphorus and Sulphur cycles and their significance, Decomposition of organic matter in aquatic ecosystem. **Unit - II** **Methods of studying microorganisms** Quantitative estimation of microorganisms in aquatic ecosystems, Collection, isolation, cultivation and characterization of microorganisms, Study of Biofilm, Nutrition & growth of microorganisms, Preservation of aquatic microbes, culture collection centers. **Unit - III** **Etiology and Therapy of fish diseases** Physical, chemical and physiological defense mechanisms in fishes, Methods of pathological examination of fish, Diagnostic tools: Histopathological methods, PCR, ELISA. Mode of action of drugs, Use of Anti parasites, Sedatives, Disinfectants, Use of Probiotics, regulation of the use of drugs in aquaculture. **Unit - IV** **Quality control of fish** Post mortem changes (Hypermia, Riger mortis, Autolysis, Microbial Pultrification, Auto oxidation) Fish pathogens; their prevention and control, Microbial quality control of processed fishery products, HACCP.						
Reference Books	1. Frazier, W.C and Westnoff, D.C. (2008). Food microbiology, Tala McGraw hill publishing company, New Delhi. 2. Jay, J.M. (2005). Modern food microbiology, CBS publishers, New Delhi. 3. Modi, H.A. (1995). Elementary microbiology, Ekta Prackashan, Nadiyad. 4. Mukundan, M.K. and Balasubramaniam, S. (2007). Seafood quality assurance, central Institute of Fisheries Technology, Cochin. 5. Munn, C.B. (2004). Marine microbiology, Bio-Scientific publishers, London & New York. 6. Patel, R.J. and Patel, K.R. (2000). Experimental microbiology, Aditya, Ahmedabad, India. 7. Rheinheimer, G.C. (1974). Aquatic microbiology, John Wiley and sons, England. 8. Sigee, D.C. (2005). Freshwater microbiology, John Wiley and Sons, England.						

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9. Surendran, P.K., Thampuran, N., Nambiar, N.V. and Laliha, K.V. (2009). Microbiological examination of seafood. Central Institute of Fisheries Technology, Cochin.
10. Whitman, K.A. (2004). Finfish & shellfish bacteriology, CBS publishers, New Delhi.
11. Willey,M.J., Sherwood, L.M. and Woowerton, C.J. (2008). Prescott, Harley and Klein’s microbiology, McGraw hill campany, New Delhi.
12. Schaperclaus, W. (2001) : Fish diseases Vol I & Vol II, Oxonian Press Pvt. Ltd., New Delhi.
13. Mitra, A. & K. Banerjee. (2004). Marine Microbiology, Narendra Publishing House, Delhi.
14. Pelezar, M.J., E.C.S. Cahn & H.R. Krieg (1981). Elements of Microbiology. McGraw Hill Book Co., NY.
15. Rosenberg, E.B. & I.R. Cohen (1983). Microbial Biology. CBS College Publ., NY.

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<tr><td>Teaching Methodology</td><td>Classwork, Discussion, Self-Study, Assignment, ICT</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, assignment and internal examination, 70% External based on University examination.</td></tr>
<tr><td>Course Code</td><td>104</td></tr>
<tr><td>Course Title</td><td>Planktonology</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course is to develop conceptsof planktonologyand learn their implementation in aquaculture sectors, commercial sector and aquatic resource management.</td></tr>
<tr><td>Course Objective</td><td>To acquire skillin students to identify plankton and their implementation as bioindicators.To measure productivity and its application in aquaculture sectors, commercial sector and aquatic resource management.</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : Develop concept among the students for the importance of plankton and Productivity. Different adaptations found in plankton and its application in science. Ecological and Commercial Importance of primary producers and secondary producers.
CO2 : After learning this course, students will be able to develop skill to identify plankton and measure productivity and its application in aquaculture sectors and aquatic resource management as well as extracted material from plankton has importance in commercial sector.
CO3 : Students will also be able to learn about the importance of plankton as one of the bioindicators of the environmental condition and their use as one of the biomarkers.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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	CO3
Pre-requisite	Basics of Biology
Course Content	Unit - I Introduction of plankton: General classification, collection of plankton general account of instruments and nets employed, Methods of fixation and preservation of plankton. Regional differences in (primary and secondary) production. Unit - II Productivity: Method of estimation of Primary productivity, secondary and tertiary productivity, factors affecting productivity. Estimation of standing crop-wet and dry weight estimation - plankton volume setting and displacement method. Oxidation as carbon. (as organic matter) Unit - III Mechanisms in plankton: Adaptation of plankton – structural (weight, increases of surface area, floatation) and physiological (specific gravity, water content, fat content, defensive vacuoles, gas, mono and divalentions) mechanisms, Interrelation of phytoplankton and zooplankton, Harmful algal blooms - its causes and effects Unit – IV Ecological and Commercial Importance of primary producers: Effects of plankton production in aquatic environment. Microalgae as a source of protein. Periphyton - Importance of Periphyton in aquatic environment, Biofuel and other commercial products from algae. Types of larvae and their distribution, chemical communication and settlement of larvae of marine benthic organisms.
Reference Books	1. Edmondson, W.T. (1976). Freshwater Biology. 2nd Ed. John Wiley (Ed) and sons Inc. 2. Hutchinsn, G.E. (1976). A treatise on limnology. Vol. I & II John Wiley & Sons. 3. Jhingran, V.G. (1985). Fish and fisheries of India. Hindustan Publication Corp., New Delhi 4. Nybakken, J.W.(2001). Marine Biology an Ecological Approach 4th edition. Addison Wesley Edu. Pub. Inc. 5. Peter McRoy, C. and G. Helferich (1977). Sea grass Ecosystems. A scientifique perspective. Marcel Dekker Inc. New York 6. Sumich, J. l. (1999). Introduction to the biology of marine life 7th Edition. The McGraw hill Companies Inc. 7. Welch. P.S. (1952). Limnology. 2nd Ed. McGraw Hill Book Co.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, Using models, ICT
Evaluation Method	30% Internal assessment based on class attendance, assignment,

	internal examination, etc. 70% External based on University examination
Course Code	**105**
Course Title	**Water & Sediment analysis and Instrumentation**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The main purpose of the course is to make students acquainted with the practical concepts. The student will gain the knowledge for analysis of water and sediment and the use of different types of instruments used for specific analysis.
Course Objective	The objective of the course is to make the student capable of analysing different physico chemical parameters in water and sediment. Students will be capable of handling instruments used for analysis of water and sediment parameters.
Course Outcomes	CO1: Students will be capable of estimating different physico-chemical parameters such as light penetration, TS, TSS and TDS, Dissolved oxygen, Alkalinity (PA & TA), Hardness (total, Ca & Mg) Chloride, in water and Silicate, Ammonia and Ammoniacal nitrogen in both water and sediments. CO2: Develop skill for standardization and measurement of water quality by using instruments like Turbidometer, pH meter, Colorimeter, Conductivity meter and Salinometer. CO3: Gain practical knowledge by field visits to different Aquafarms and processing plants in respect to fish and fisheries. CO4: Acquire skill to check water and sediment quality with reference to physico- Chemical parameters for the management of fisheries CO5: The acquired practical skill will help in further research works
Mapping between COs with PSOs	
Pre-requisite	Basics of biology and chemistry
Course Content	• Titrimetric estimation of ➢ Dissolved oxygen, ➢ Alkalinity(PA & TA), ➢ Hardness (total, Ca & Mg)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						
CO5						

	➢ Chloride • Colorimetric estimation of water and sediments ➢ Silicate ➢ Ammonia ➢ Ammonical nitrogen • Light penetration, TS,TSS and TDS estimation • Instrumentation: Standardization and measurement of water quality by following instruments ➢ Turbidometer ➢ pH meter ➢ Colorimeter ➢ Conductivity meter ➢ Salinometer • Field and Institutes visits
Reference Books	1. APHA (2005). Standard method for the examination of water and wastewater, American Public Health Association, E.G. Arnold, S.C. Lenore, A.E. Eaton (Eds.), Washington. 2. Trivedy, R.K. and Goel, P.K (1986). Chemical and biological methods for water pollution studies, Environmental publication, Karad. 3. Skoogs, H, P.and Nieman, M (2006). Principle of Instrumental analysis. Thomson Inc Ltd. 4. Brown, S.B (1980). An introduction to spectroscopy for Biochemists, Academic press, London, New York.
Teaching Methodology	Demonstration, Explanation, Practical, Discussion, Journal preparation
Evaluation Method	30% Internal assessment based on class attendance, internal examination, etc. 70% External based on University examination
Course Code	**106**
Course Title	**Planktonology and Microbiology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to make the student able of implementing the methods of planktonology and microbiology as well as develop the skill to count and identify plankton and microorganisms in the field of Aquatic Biology.
Course Objective	To make students familiar about plankton and microorganisms associated with aquatic environment with its importance.
Course Outcomes	CO1 :Quantitative and chlorophyll estimation of plankton help to measure the productivity andaquatic resources. CO2 :Students will able to perform qualitative estimation of plankton for aquatic resource management. CO3: The counting and identification of microorganisms through SPC, MPN, Gram's staining and hanging drop and membrane filter

<table>
<tr><td></td><td>techniqueaids to determine the importance and safety level of microorganisms in concern toaquatic production and environment.
CO4: Explore students through field and institutes' visitswhich make themto understand the interaction between their chosen fields of study to the rest of the world. It also provides an exposure to students about practical working environment.</td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Planktonology and Microbiology</td></tr>
<tr><td>Course Content</td><td>1. Collection, fixation and preservation of plankton (freshwater and marine water).

2. Quantitative estimation of plankton (counting method) & chlorophyll estimation.

3. Identification of Phytoplankton(freshwater and marine water).

4. Identification of Zooplankton(freshwater and marine water).

5. Examination of bacteria by Gram's staining technique and hanging drop technique.

6. Isolation Methods for bacteria.

7. Estimation of Vibrio sp.andStreptococus faecalisby membrane filter technique.

8. Assessment of microbiological quality of water bodies using SPC and MPN techniques.

9. Quantitative assessment of microbiological quality of sediments and fish products using SPC.

10. Field and Institutes visits.</td></tr>
<tr><td>Reference Books</td><td>

Patel, R.J. and Patel, K.R. (2000). Experimental microbiology, Aditya, Ahmedabad, India.
Surendran, P.K., Thampuran, N., Nambiar, N.V. and Laliha, K.V. (2009). Microbiological examination of seafood. Central Institute of Fisheries Technology, Cochin.
Willey,M.J., Sherwood, L.M. and Woowerton, C.J. (2008). Prescott, Harley and Klein's microbiology, McGraw hill campany, New Delhi.
Pelezar, M.J., E.C.S. Cahn & H.R. Krieg (1981). Elements of Microbiology. McGraw Hill Book Co., NY.
APHA, (1995). Standard method for examination of water

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	and waste water (19th ed.), American public health association, New York. 6. M. Cheesbrough, (2002). District laboratory practice in tropical countries, Cambridge University press, USA. 7. J. G. Cappuccino and N. Sherman, (2005). Microbiology (6th ed.), Pearson education Pvt. Ltd., Indian branch, Delhi, India. 8. R. Ananthanarayan and J. Paniker, J. (2009). Textbook of microbiology. Universities press Pvt. Ltd. 9. Battish, S.K. (1992). Freshwater zooplankton of India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 10. Desikacharya, T.V. (1987-1991). Atlas of Diatoms Fasc.1-6. Madras Science foundation. 11. Nybakken, J.W. (1988). Marine Biology: An ecological approach (2nd ed.). Harper Collins Publisher. 12. Pillai, N.K. (1986). Introduction to Planktology. Himalaya Publishing House, Bombay. 13. Sarode, P.T. and Kamant, N.D., (1984). Freshwater diatoms of Maharastra. SaikrupaPrakasan, Aurangabad.
Teaching Methodology	Practicalperformance anddemonstration, Discussion, Self-Study, ICT, Field visit
Evaluation Method	30% Internal assessment based on class attendance, assignment and internal examination, 70% External based on University examination.

AQB 2nd Semester

Course Code	**201**
Course Title	Fish Nutrition, Biochemistry and Feed Technology
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The main purpose of the course is to make students acquainted with concepts of Fish Nutrition, fish Biochemistry and Feed Technology
Course Objective	The objectives of the course is to make the student capable of understanding the general fish nutrition, biochemistry, Chemical and Biological analysis and different methods used in fish feed Technology.
Course Outcomes	CO1: The course explains the general fish nutrition so as to manage the fishery resources CO2:Biochemistry, Chemical and Biological analysis of feed and muscles of fish. CO3: Explain the skills required in feed Technology. CO4:Explain the skill to measure Gastro-somatic Index (GaSI), Feed Conversion Ratio (FCR), Food Conversion Efficiency (FCE), Protein Efficiency Ratio (PER), Productive Protein Value (PPV), Net Protein

	Utilization (NPU) in order to manage fish resources in natural resources and farms CO5:Explain the process of feed formulation, feed processing and feed manufacture
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						
CO5						

Pre-requisite	Basics of biology and chemistry
Course Content	Unit - I ➢ General fish nutrition: Principles of nutrition. Types of aqua feed. Nutritional requirements of fish and prawn at various developmental stages Unit - II ➢ Biochemistry: Importance Carbohydrates, Protein, Lipid (energy food), Minerals and Vitamins (non energy food), Proximate composition of fish and feeds Unit - III ➢ Chemical and Biological analysis: Gastro-somatic Index (GaSI), Feed Conversion Ratio (FCR), Food Conversion Efficiency (FCE), Protein Efficiency Ratio (PER), Productive Protein Value (PPV), Net Protein Utilization (NPU) Unit – IV ➢ Feed Technology: Feed processing and manufacture machineries, Sources of feed ingredients, eco-friendly and Economic feed formulation. Role of feed attractants, binders, growth promoters (antibiotics, probiotics), coloring and flavoring agents, Antinutritional factors, method of feed formulation (mixing, grinding, pulverizing, cooking, extruding, pelleting, drying packing)
Reference Books	1. ADCP (Aquaculture Development and Co-ordination Programme) (1980). Fish Feed Technology, ADCP/REP/80/11.FAO, Rome. 2. D' Abramo, LR., Conklin, D.E and Aklyama. D.M, (1977). Crustacean Nutrition: Advances in Aquaculture Vol. 6. World Aquaculture Society, Baton Roughe, L.A. 3. Evans, D.H. and Claiborne, J.B. (2006). The Physiology of fishes. CRC press. 4. Guillame, J., Kaushik, S., Berqot P., and Metallier, R., (2001). Nutrition and feeding of fish and crustaceans, Springer Praxis Publishing, Chichester, UK. 5. Halver J.E. (1989). Fish Nutrition, Academic Press, San Diego, CA. 6. Halver, J and Hardy, R.W. (2002). Fish nutrition. Academic press, London. 7. Halver, J.E, and Tlews, K.T. (1979). Finfish nutrition and fish feed technology Vol. I and II Heenemann, Berlin

	8. Hepper, B. (1988). Nutrition of pond fishes. Cambridge Univ. Press, Cambridge, UK. 9. Houlihan, D., Boujard, T and Jobling, M. (2001). Food intake in fish. Blackwell science Ltd, London. 10. Joachim W. Hertrampf and Felicitas Piedad-Pascual. (2000). Handbook on ingredients for aquaculture feeds. Kluwer Academic Publishers, London. 11. Jobling, M. (1994). Fish Bioenergetics. Chapman & Hall. London. 12. Keith Wilson and John Walker. (1995). Principles and Techniques of Practical Biochemistry. Cambridge University Press. 13. Lovell, R.T. (1998). Nutrition and Feeding of Fishes, Chapman & Hall, New York. 14. New, M.B. (1987). Feed and feeding of fish and shrimp. A manual on the preparation and preservation of compound feeds for shrimp and fish in aquaculture. F.A.O. Rome – ADCP/REP/87/26. 15. Rechcigl, M. (1977). CRC Handbook series in nutrition and food. CRC press. 16. Rechcigl, M. (1981). Handbook of nutritional supplements in a functional context. CRC press. 17. Sena S. De Silva, Trevor A. Anderson. (1995). Fish Nutrition in Aquaculture, Chapman & Hall Aquaculture Series, London
Teaching Methodology	Classwork, Discussion, Self-Study and Assignment
Evaluation Method	30% Internal assessment based on class attendance, assignments and internal examination. 70% External based on University examination
Course Code	**202**
Course Title	**Fish Genetics and Biotechnology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to develop the skill about executing the different scientific methods of Fish genetics and biotechnology in field of Aquatic Biology with reference to improvingaquaculture production and quality.
Course Objective	To make the students acquaintregarding fundamentals of molecular biology, principle of fish genetics, fish biotechnology, bioinformatics, nanotechnology and its applications.
Course Outcomes	CO1 :Inculcate students about fundamentals of Molecular biologylike structure of DNA and RNA, DNA replication, mutation, transcription and translation to understand formations, actions, and regulations of various parts of cells which can be used to efficiently target new drugs, diagnose disease and understand the physiology of the cell. CO2: Explain students aboutstructure of chromosome with help of banding techniques, fish as a cytogenetic model,application of molecular biology techniqueslike sex-reversion, chromosomal manipulation and transgenic fish for increasing aquaculture production by genetically modifying

	aquatic organisms andfish population management. CO3: This paper describes scope and application of fish biotechnology with the help of different techniques like PCR, cryopreservation and vaccinationwhich helps in molecular and genetic diagnostics as well as genetic upgradation of cultivable species with minimum risk of infection. CO4: Train students to deal withbioinformatics and nanotechnology in the field of Aquatic Biology. It provides the skillful digital database information which certainly required for aquatic resource management.
Mapping between COs with PSOs	<table><tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr><tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>
Pre-requisite	Basics of Genetics and Biotechnology
course Content	**Unit - I** **Fundamentals of Molecular Biology** DNA as a genetic material, DNA replication and Mutations, Structure and Types of RNA, Transcription, protein synthesis. Recombinant DNA technology, DNA barcoding. **Unit - II** **Principle of fish genetics** **Chromosome study:** Fish chromosome preparation method, Banding techniques, Fish as a cytogenetic model. **Genetic manipulation:** Sex-reversion and sex control, Chromosomal manipulation. **Transgenic fish** **Unit - III** **Fish Biotechnology** Scope and application PCR technique, Cryopreservation, Vaccination in fish biotechnology. Hybridization: Significance of hybridization, modification in genomic structure of hybrid offspring, characteristics of hybrids, natural and artificial hybridization. **Unit - IV** **Bioinformatics:** Use of computers in Bioinformatics, Search engines and Databases, Application of Bioinformatics in Aquatic Biology. **Nanotechnology:** Introduction, History, Applications in aquatic biology.
Reference Books	1. Arthur M. Lesk (2003). Introduction to Bioinformatics, Oxford Uni.Press. 2. Falcon, D.S. (2000). An Introduction to quantitative genetics ELBS publisher, England. 3. Lakra W.S. (2000). Fish Genetics and Biotechnology CIFE, Mumbai. 4. Lewin Benjamin (2008). GENES- IX London; Jones &Bartler Publ. 5. Michel & Notre C.D. (2003). Bioinformatics, A Beginners Guide Wiley Publ.Inc. 6. Murthy C.V.S. (2004). Bioinformatics Himalaya publishing House.

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7. Rashidi H. H., and L.K. Buehler (2003). Bioinformatics Basics: Applications inBiological sciences and Medicine.
8. Sinnit E.W., Dunn L.C. and Dobzhansky, T. (1998). Principle of Genetics, Macgrodo hillpublishing company Ltd.
9. Krebs & Jocelyn. (2013). Lewin's Essential Genes. Jones &Barlett Learning.
10. Lakra, W.S., S.A.H. Abidi, S.C. Mukherjee and S. Ayyappan (2004). Fisheries Biotechnology. Narendra Publ. House.
11. Lewin & Benjamin. (2008). Genes lX. Jones &Barlett publishers, Massachusetts.
12. Lodish, H., A. Berk, P. Matsudaira, C.A. Kaiser, M. Krieger, M.P. Scott and C.G. Lutz (2003). Practical Genetics for Aquaculture, Wiley-Blackwell.
13. Lehninger, A.L. (2004). Principles of Biochemistry, 4th edition, W.H Freeman and Company.
14. Muralidharan, V.S. & A. Subramania. (2009). Nanosciences& technology, Ane Books Pvt. Ltd., New Delhi.
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<tr><td>Teaching Methodology</td><td>Classwork, Discussion, Self-Study, Assignment, ICT</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, assignment and internal examination, 70% External based on University examination.</td></tr>
<tr><td>Course Code</td><td>203</td></tr>
<tr><td>Course Title</td><td>Aquatic Pollution and Toxicology</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course is to develop concepts of water pollution and toxicological studies. Also to learn how to manage aquatic resources.</td></tr>
<tr><td>Course Objective</td><td>To develop skill in students to identify pollution load, biomarkersinaquatic resource and how to develop bioassays.
To acquire knowledge to monitor aquatic resources and conduct toxicity test.</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : To know about the sources of water pollution, fate of pollutants in Aquatic eosystems, Effluents and their treatment and concept of Toxicology.
CO2 : Acquire knowledge to monitor pollution load, control and prevention of pollution by various methods.
CO3: Develop the skill to conduct Toxicity test i.e. Bioassay, Biostimulation and Bioinhibition
CO4: Acquire skill to identify Biomarkers as water quality monitoring tool.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Pre-requisite	Basics of Biology and chemistry
Course Content	**Unit – I General Introduction:** Water pollution: sources, Fate of pollutants in Aquatic system, their monitoring and control in water bodies. Interaction of pollutants and factors affecting toxicity **Unit - II Effluents and their treatment:** Sewage, industrial and agricultural discharges. Characteristics of effluent, Biological concern: Eutophication, Bioaccumulation and Biomagnification, waste water treatment methods. water quality standards (Stream and effluent standards) and water quality indices. **Unit - III Pollution:** Thermal pollution, Oil pollution, Radioactive pollution, Detergent pollution- Their sources, fate, biological effects and management. Acid rain and its effects in aquatic system Role of Central Pollution Control Board (CPCB) and Gujarat Pollution Control Board (GPCB) in management of pollution. **Unit - IV Toxicology**: Basic toxicological concepts and principles, classification of toxicants-metals, pesticides, teratogens, xenobiotics, toxin of animal and plant origin, Toxicity test procedures: Bioassay, Biostimulation and Bioinhibition, Biomarkers as water quality monitors.
Reference Books	1. Agarwal, S.K. (2008). Water pollution, ABH publishing corporation, New Delhi 2. Albert, A. (1951). Selective toxicity, John Wiley and Sons, Chichester 3. Cremlyn, R. (1978). Pesticides, John Wiley and Sons, Chichester 4. Ghosh, G.K. (2002). Water of India, A.P.H. publishing corporation, New Delhi 5. Goel, P.K. (2006). Water pollution, New age international publishers, New Delhi. 6. Kukal S.S. and Dhaliwal, G.S. (2005). Essential of environmental science, Kalyani Publishers, Ludhiyana 7. Prabhakar, V.K. (2001). Marine ecology & pollution, Anmol publications New Delhi. 8. Rand, G.M. (1995). Fundamentals of Aquatic toxicology, Taylor and Francis, Washington, D.C. 9. Rao, M.K. (2007). Environnemental pollution & Toxicology, Manglam publishers, Delhi. 10. Salpekar, A.C. (2008). Marine pollution, JnanadaPrackashan, New Delhi 11. Schmitz, R.J. (1995). Introduction to water pollution Biology, Gulf publishing company, Texas

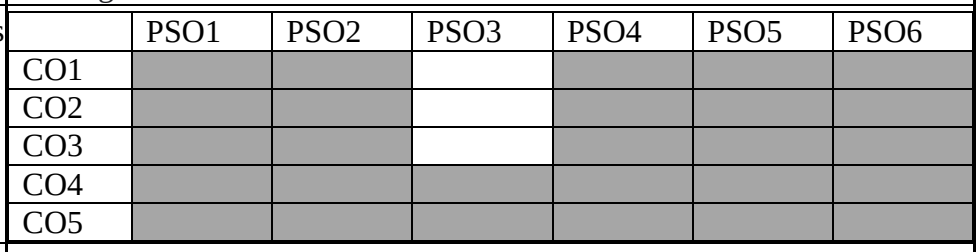
	12. Sinha, P.C. (1998). Marine pollution, Anmol Publications, New Delhi 13. Trivedi, R.K. and Goel, P.K.(1984). Chemical & Biological methods for water pollution studies, Environmental publications, Karad 14. Trivedi, R.K. (2001). Aquatic Pollution & Toxicology, ABD publishers, Jaipur.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, ICT
Evaluation Method	30% Internal assessment based on class attendance, assignment, internal examination, etc. 70% External based on University examination

CourseCode	AQB 204
Course Title	Biostatistics, Extension Education and Fisheries Legislation
Credit	4
Teaching per week	4
Minimum weeks per semester	16
Effective from	June 2020
Purpose of course	The purpose of the course is to develop the analysis methodology, dissemination methods of the innovations and regulations of the fisheries resources which would be helpful for the formation of the database and resources management.
Course objective	To acquaint the students about the biostatical methods, innovation dissemination and fisheries resources regulations.
Course Outcome	CO1. Theapplication of bio-statistical analysis in the field of aquatic biology help for resource management. CO2. The innovations are not essential but its application at needful field are also useful and it would be possible to teach the students about fisheries extension education. CO3. The fisheries extension education essential to develop the communication skill, training strategies, contact methods etc. certainly help to disseminate the innovation and technologies to beneficiaries. CO4. The inland fisheries policies implemented by the state and central government are elaborated to students to improve the knowledge and technical skill. CO5. The explanation regarding the marine fisheries regulation andinternational law of the sea develop the knowledge and awareness for fisheries management.

Mapping of COs with PSOs		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
	CO1						
	CO2						
	CO3						
	CO4						
	CO5						

Course prerequisite	Biological data of fish, communication and contact tools and basic equipments for aquaculture.
	Unit I (Hrs. 12) Fundamental of Biostatistics: Biostatistics Introduction, Sampling techniques, Standard deviation,

	Standard error, co- efficientof Variation, Correlation and regression, Hypothesis testing (Student test, 't' test, X^2 test and 'f' test), Analysis of variance (ANOVA) **Unit II(Hrs. 14) Fisheries Extension Education:** Fisheries extension education: Introduction, principle, functionaries,Extension methods, Diffusion of innovation, communication, training strategies in transfer of technologies, role of farmers-extension and research linkages. Entrepreneurship development process. Cooperatives Principles, role, structure and organisations. **Unit III (Hrs.12) Inland and Marine Fisheries Regulation and Development**: Inland fisheries Act, Leasing policies for water bodies, Biodiversity Act, Aquaculture Authority Act, Maritime Zones of IndiaAct 1981. Coastal Regulation Zone (CRZ) and Integrated Coastal Zone Management (ICZM) in the context of aquaculture sustainability. **Unit IV (Hrs. 07) International Law of the Sea:** Historical perspectives, Exclusive Economic Zone, Regulatory and developmental issues concerning deep sea fishing – Guidelines for operation Indian deep sea fishing vessels in Indian EEZ.
References	1. Branson, E.J. (2008). Fish welfare. Pub. Blackwell Publication, Oxford. 2. Malhotra, S.P. & Sinha, V.R.P. (2007). Indian Fisheries and Aquaculture in A Globalizing Economy, 2 Vols. Narendra publishing house New Delhi. 3. Coupes, A., and Edgar, H. (1987). The marine environment and sustainable development; law, policy and science law of the sea institute, Honolulu. 4. G.W. (2009). Towards Sustainable Fisheries Law: A Comparative Analysis. IUCN Environmental Policy and Law Paper No. 74. IUCN publication Service, Switzerland 5. O'Connell, D.P. (1982). The international law the sea. Clarendon press. 6. William E, Devid F, and Elly G. (2001). Legislating for Sustainable Fisheries : A Guide to Implementing the 1993 FAO Compliance Agreement and 1995 UN Fish Stocks Agreement Published by World Bank. 7. Biradar, R.S. (1986): Course manual on fisheries statistics, Central Institute of Fisheries Education, Mumbai 8. Dahama, O.P. (1983): Extension and rural welfare. Ramprasad and Son's, Agra 9. Dhote, A.K. (1989): Fisheries Management and Extension: Inland fisheries, instructional cum practical manual (VI) NCERT, New Delhi 10. Lynton P.R. and Pareek, U. (1978): Training for development, Kumarian Press, 29 Bishop Road, West Hartford, Connecticut 06119 11. Panse, V. G. and Sukhatme, P.V. (1978): Statistical methods for agricultural workers, ICAR, New Delhi. 12. Raghava Rao, D. (1983): Statistical techniques in agricultural and biological research, Oxford and IBH Publishing Co., Mumbai 13. Ray, G.I. (1991): Extension communication and management, Naya

	Prakash, Kolkatta
Teaching methods	Chalk and talk, Discussion, Videos, Self-study, Seminars and Assignments
Evaluation methods	Internal assessment (30%) based on the internal exam, attendance and assignments. External assessment (70%) based on the university examination at the end of the semester.
Course Code	**205**
Course Title	**Biochemistry, Genetics and Biotechnology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to develop the skill about executing the different scientific methods of Biochemistry, Genetics and biotechnology in field of Aquatic Biology with reference to improving aquaculture production and quality.
Course Objective	To make the students acquaint aboutbiochemical quantification of fish and feed, Quantitative estimation of DNA, staining of DNA and RNA, banding techniques, Demonstration of PCR, COMAT ASSAY and Electrophoresis, Information retrieval from sequence databases and sequence alignment using BLAST.
Course Outcomes	CO1 :Biochemical quantification of fish and feed is essential for consumption purposeto make legitimate comparisons of best suitable feeds and fish on the basis of nutritional requirements of human being. CO2: Quantitative estimation of DNA, staining of DNA and RNA as well as study of banding techniques helps in aquatic resource management. CO3: Demonstration of PCR, COMAT ASSAY and Electrophoresis helps in molecular and genetic diagnostics. CO4: Information retrieval from sequence databases and sequence alignment using BLASTprovides the skillful digital database informationfor aquatic resource management. CO5: Explore students through field and institutes visits which make them to understand the interaction between their chosen fields of study to the rest of the world. It also provides an exposure to students about practical working environment.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biochemistry, Genetics and Biotechnology
Course Content	1. Biochemical quantification of (Protein, Lipid, Sugar and Ash) in fish.

	2. Biochemical quantification of (Protein, Lipid, Sugar and Ash) in feed. 3. Feed formulation by Pearson square formula. 4. Demonstration: Isolation of DNA from aquatic organism. 5. DNA Staining using Schiff's reagent in aquatic plants. 6. RNA staining by Pyronine-Y and toluidine blue in aquatic plants. 7. Study of banding techniques with the help of images. 8. Demonstration : PCR, COMAT ASSAY, Electrophoresis. 9. Information retrieval from sequence databases. 10. Sequence alignment using BLAST. 11. Field and Institutes visit
Reference Books	1. Biology Genetics Molecular Biology (2009) by Dipak Kumar Kar and Soma Halder, New Central Book Agency, Kolkata. 2. Cell Biology (2008) by Satyesh Chandra Roy and Kalyan Kumar De, New Central Book Agency, Kolkata. 3. Arthur M. Lesk (2003). Introduction to Bioinformatics, Oxford Uni.Press. 4. Lakra W.S. (2000). Fish Genetics and Biotechnology CIFE, Mumbai. 5. Murthy C.V.S. (2004). Bioinformatics Himalaya publishing House. 6. Sinnit E.W., Dunn L.C. and Dobzhansky, T. (1998). Principle of Genetics, Macgrodo hillpublishing company Ltd. 7. Lodish, H., A. Berk, P. Matsudaira, C.A. Kaiser, M. Krieger, M.P. Scott and C.G. Lutz (2003). Practical Genetics for Aquaculture, Wiley-Blackwell.
Teaching Methodology	Practicalperformance and demonstration, Discussion, Self-Study, ICT, Field visit
Evaluation Method	30% Internal assessment based on class attendance, assignment and internal examination, 70% External based on University examination.

Course AQB-206 Aquatic Pollution and Biostatistics

Course Code	206
Course Title	Aquatic Pollution and Biostatistics
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to develop skill for water pollution monitoring, toxicity test and biostatistics to manage aquatic resources.
Course Objective	To develop skill to manage water pollution monitoring.

<table>
<tr><td></td><td>To develop skill to find impact of pollution on aquatic organisms.
To implement the statistical analysis at different levels.</td></tr>
<tr><td>Course Outcomes</td><td>CO 1: Students will be able to develop basic concept of pollution and biostatisticsto manage aquatic resources.
CO 2: Develop the skill to estimate amount of pollutant from water and sediment to check it’s quality for water resource management.
CO 3: Capable to find impact of pollution on fish and their remedies.
CO 4: Develop skill to prepare permanent histological and histopathological slide of fish organs and their observations.
CO 5: Conduct Bioassay test for toxicity.
CO 6: Carry out statistical analysis such as Standard deviation, CV, SE, Independent t-test, Paired t-test, Chi square test, co-relation, regression, ANOVA and apply in the field of Aquatic Biology.
CO 7: Apply developed skill for prevention and control of water pollution.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO7</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Biology and chemistry</td></tr>
<tr><td>Course Content</td><td>• Estimation of BOD and COD
• Colorimetric estimation of inorganic phosphate, nitrate, nitrite from water and sediment
• Preparations and observations of slides for micronuclei test in fish blood
• Histology : Fixation, embedding sectioning and staining of fish tissues
• Histological and histopathological observations of fish tissue
• Demonstration: Observation of behavioral changes and determination of LC_{50}
• Standard deviation, CV, SE, Independent t-test, Paired t-test, Chi square test, co-relation, regression, ANOVA.
• Field and Institutes visit</td></tr>
<tr><td>Teaching Methodology</td><td>Classwork, Discussion, Self-Study, Practical, Demonstration, Field Visit, Institute visit</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, internal examination, etc. 70% External based on University examination</td></tr>
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AQB 3rd Semester

Course Code	**301**

<table>
<tr><td>Course Title</td><td>Fish Physiology, Endocrinology & Disease Management</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The main purpose of the course is to make students acquainted with concepts of fish physiology, endocrinology and disease management in fishes.</td></tr>
<tr><td>Course Objective</td><td>The objectiveof the course is to make the student capable of understanding the general physiological functions like respiration, digestion, excretion, circulation, osmoregulation, reproduction and development and endocrinology in fishes. The course also make student capable of managing fish diseases.</td></tr>
<tr><td>Course Outcomes</td><td>CO1:To understand the concept of fish physiological processes (digestion, respiration, circulation, excretion, osmoregulation, reproduction and development), endocrinology, fish diseases and health management).
CO2:Helps student develop the skill for health and disease management in fish farming sector
CO3:Trains student for applying hormonal knowledge for sex reversal in fishes
CO4: Explain students about recent technologies used for managing and handling diseases fish
CO5:Trains students to develop career in fish management.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>Pre-requisite</td><td>Basics of biology and chemistry</td></tr>
<tr><td>Course Content</td><td>Unit - I
➢ Digestion: Digestive system of fish and associated digestive glands (liver, pancreas and gall bladder), Mechanism of digestion
➢ Respiration: Structure and function of gills, Mechanism of respiration, Hemoglobin – Oxygen Uptake and Dissociation, accessory respiratory organs
Unit - II
➢ Circulation: Blood and its components. Structure of heart and function
➢ Excretion : Structure and function of kidney, nitrogenous end products and pattern of their excretion
➢ Osmoregulation : Introduction, Osmoregulation in fresh water, brackish water and marine water fish</td></tr>
</table>

	Unit - III ➢ Reproduction & Development: Reproductive system of fish, Structure and function of gonads, Fecundity, Fertilization, Incubation, Hatching, Larvae and Metamorphosis ➢ Endocrinology: Hormonal control of pineal, thyroid, pituitary gland in fishes, pancreatic hormone in fishes, Endocrinology of ecdysis in crustacean. Role of hormones in sex reversal in fish. Unit – IV ➢ Fish Diseases & Health Management ➢ Pathogenic diseases: symptoms and control Bacterial, Fungal, Viral diseases in fin fishes & shell fishes ➢ Parasitic diseases: symptoms and control ➢ Protozoan, Crustacean, and Worm diseases in fin fishes & shell fishes ➢ Non-pathogenic diseases: symptoms and control ➢ Algal, Environmental, Nutritional and Hereditary disease
Reference Books	1. Evans, Devid H. (1998): Physiology of Fishes. R.R. Bowker Company, book trade association of Philadelphia. 2. Hoar, W. S. and Randal, D. J. (1993): Fish endocrinology Vol. I to VII. Academic press, INC (London) Ltd. 3. Hoar, W. S., Randal, D. J. and Farrell, A. P. (1992): Cardiovascular system, Vol. 12, Part 2 of Fish Physiology, Academic Press. INC London Ltd. 4. Khanna S.S. (1989): An Introduction to Fishes. Central Book Depot, Allahabad. 5. Khanna S.S. and Singh, H.R. (2003): A text book of fish biology and fisheries. Narendra publishing house, New Delhi – 110 006. 6. Nikolsky, G.Y. (1989): The ecology of fishes. Academic Press, London. 7. Pandey A.K. and Sandhu G.S. (1992): Encyclopedia of fishes and fisheries of India Vol. I & IV, Amol publication, New Delhi. 8. Prosser, C. L. (1973): Comparative Animal Physiology, W. B Sounders Co., Philadelphia 9. Smith, L.S. (1982): Introduction of fish physiology. Narendra publishing house, New Delhi. 10. Yadav, B. N. (2006): Fish & Fisheries, Daya Publishing House, New Delhi. 11. Yadav, B.N. (1995): Fish endocrinology. Daya Publishing House, New Delhi. 12. Anderson, D.P. (2003): Text book of fish Immunology, Narendra publishing house, Delhi 13. Austin, B. (1999): Bacterial fish pathogen-Disease of farmed and wild fish, Paraxis publishing Ltd., U.K 14. Conroy, D.A. (1997): Textbook pf fish diseases, Narendra publishing house, Delhi 15. Cornell, J.J. (1995): Control of fish quality, Fishing new books

<table>
<tr><td></td><td>16. Duijn, C.V. (2000): Diseases of fishes, Narendra publishing house, Delhi
17. Inglis, V. (1993): Bacterial diseases of fish, Blackwell science Ltd., Oxford, U.K.
18. Roberts, R.J. (1982): Microbial diseases of fish, Society for general microbiology academic press, New York, USA
19. Roberts, R.J. (1978): Fish pathology, Baillere Tindall, Landon
20. Sharma, O.P. (2009): Handbook of fisheries and aquaculture, Agrotech publishing academy, Udaipur
21. Wedemeyer, G.K. (1999): Environmental stress and fish diseases, Narendra publishing house, Delhi
22. Woo, P.T.K. and Leatheland, F. (1998) : Fish diseases and disorders, CABI publishers, Wallingford</td></tr>
<tr><td>Teaching Methodology</td><td>Classwork, Discussion, Self-Study, and Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, assignments, and internal examination.
70% External based on University examination</td></tr>
<tr><td>Course Code</td><td>302</td></tr>
<tr><td>Course Title</td><td>Fisheries Technology</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course is to introduce different fisheries technologies and its applications which would help and develop the skill among students for development of fisheries sectorin scientific way.</td></tr>
<tr><td>Course Objective</td><td>To introduce different fisheries technologies which would be helpful in finding, harvesting, handling, processing and distribution of aquatic resources and their products.</td></tr>
<tr><td>Course Outcomes</td><td>CO1 :Explain students about hatcheries and induced breeding which gives idea about fisheries management in concern to get pure and desired spawn of certain species of fishes and habitat conservation.
CO2:Students will be aware regarding transportation as well asage and growth of fisheswhich are essential for sustainable fish farming and population studies.
CO3: The students will be able to acquire the knowledge about fishing techniques to catch fishes in large scale from waterbodies efficientlyfor fishery research and management.
CO4: This paper deals with post harvest technology which helps to maintain quality (appearance, texture, flavor and nutritive value) to protect food safety, and to reduce losses between harvest and consumption.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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	CO3						
	CO4						
Pre-requisite	Basics of Fisheries Science						
Course Content	**Unit – I** **Hatcheries:** Types of Traditional, Circular, Vertical hatcheries, Shrimp/Prawn hatcheries and hatchery Management (Japanese, Galveston, Indian). **Induced breeding**: Selection of brooders, extraction of pituitary gland, preparation of dosage and injection, spawning and fertilization, stripping method, use of inducing agents in induced breeding, Eyestalk ablation technique in shrimp. **Unit - II** **Transportation:** Causes of mortality during transportation, methods for transportation of fish seeds, fingerlings, brooders and trout eggs, use of chemicals in live fish transportation**.** **Age and growth of fishes:** Utility and methods for determining age and growth, study of maturity, mortality and yield, factors affecting the age and growth. **Unit - III** **Techniques for Fishing:** Introduction of fishing crafts, types of fishing crafts (mechanized and non-mechanized). Introduction of fishing gears, types of fishing gears (Traditional, conventional, non-conventional and Active, Passive), Maintenance and preservation of fishing gears. **Remote sensing:** Mechanism, satellites and cameras, Importance and Application of remote sensing in Aquatic biology. **Unit - IV** **Post harvest technology:** Principles and techniques of processing and preservation, chilling, freezing, drying, salting, smoking, canning, pickling, pasting, preservation with chemicals, preservation by exposure of gamma rays, modern techniques of preservation, packaging of fish and fish products, Effect of processing and preservation on nutritive aspects of fish, fishery products and by-products.						
Reference Books	1. Agrawal, S.C. (1994). A hand book of fish farming, Narendra publishing house, Delhi. 2. Balachandran, K.K. (1998). Advances and priorities in fisheries technology, Cohin. 3. Biswas, S.P. (2002). Fundamentals of Ichthyology, Narendra publishing house Delhi. 4. Deekshatulu, B.L. and Rajan, Y.S. (1984). Remote sensing, Indian academy of sciences, Banglore. 5. Felix, S. (2007). Aquaculture management techniques, Narendra publishing house, New Delhi. 6. Gupta, S.K. and Gupta, P.C. (2002). General and applied						

	Ichthyology (Fish and fisheries), S. Chand and company, New Delhi. 7. Harrison, P.J. and Parsons, T. R. (2000). Fisheries oceanography, Blackwell science. 8. Jhingran, V.G. (1991). Fish and fisheries of India, Hindustan Publishing Corporation, Delhi. 9. Joseph, J. (2009). Post harvest technology of freshwater fish, Central Institute of fisheries technology, Cochin. 10. Khana, S.S. and Singh, H.R. (2003). A text book of fish biology & fisheries, Narendra publishing house, Delhi. 11. Krjstjonsson, H. (1959). Modern fishing gear of the world Vol. I, II & Vol. III, Fishing news (books).Ltd., England. 12. Malvi, S. (2008). Fish genetics, SBS publishers and distributors Pvt. Ltd., New Delhi. 13. Meenakumari, B. (2009). Handbook of fishing technology, Central Institute of fisheries technology, Cochin. 14. Moyle, P.B. (2002). Fishes-An Introduction to Ichthyology, prentice hall Inc NJ 07458. 15. Nikolsky, G.V. (1999). Ecology of fishes, Allied scientific publishers. 16. Rao, D.P. (1995). Remote sensing for earth resources, Association of exploration geophysicists, Hyderabad. 17. Rath, R. K. (2000). Freshwater aquaculture, Scientific publishers, Jodhpur. 18. Regenstein, J.M. and Regenstein, C.E. (1997). Introduction to fish technology, CBS publishers and distributors, New Delhi. 19. Sabins, F.F. (1997). Remote sensing, Principles and interpretation, W.H. Freeman & Co., New Delhi. 20. Sharma, O.P. (2009). Handbook of fisheries and aquaculture, Agrotech publishing academy, Udaipur. 21. Sreekrishna, Y. and Shenoy, L. (2001). Fishing gear and craft technology, Indian Council of Agricultural Research, New Delhi. 22. Welcomme, R.L. (2007). Inland fisheries, Discovery publishing house, New Delhi. 23. Yadav, B.N. (1997). Fish and fisheries, Daya publishing house, Delhi. 24. Yadav, N.K. (2009). Management practices in fish farming, Manglam publications, Delhi.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, ICT, Field visit
Evaluation Method	30% Internal assessment based on class attendance, assignment and internal examination, 70% External based on University examination.
Course Code	303
Course Title	Freshwater Aquaculture
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)

<table>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course is to gain knowledge about culturetechniques for freshwater organism for commercial purpose and farm construction.</td></tr>
<tr><td>Course Objective</td><td>To gain knowledge for aquafarm design and construction.
To acquire knowledge forculturing freshwater organisms for commercial purposes.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will be familiar about advancement in aquaculture, pond farm preparation, criteria for selection of species for aquaculture, culture techniquesfor freshwater aquatic organisms, equipment used in aquafarm.
CO2 : Student will develop skill for freshwater culture techniques for freshwater animal, microalgae and vascular plants.
CO3 :Students will be aware regarding best aquaculture management practices, improvement in fish quality and about more revenue generation.
CO4 : Student will be able to apply use of microalgae and higher vascular plants for waste water treatment.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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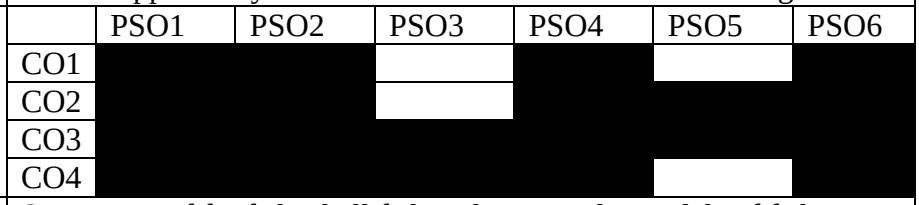
</td></tr>
<tr><td>Pre-requisite</td><td>Basics of Biology and chemistry</td></tr>
<tr><td>Course Content</td><td>Unit – I:
Introduction and Pond farm Preparation:
Definition, scope of aquaculture, Recent Advances in aquaculture, Criteria for species selection for aquaculture
Selection of site for fish farm, component pond for fish farm, designing of farm: design , size, shape and layout of farm, construction of farms: method of construction, construction material, dike design and construction, water supply and drainage systems, aerator, feeders and other equipment used in farm
Unit – II:
Culture Techniques:
Carp culture (IMC) with reference to Composite fish culture, Integrated fish farming andSewage fed fisheries
Culture of catfishes: Rearing of grow outs, harvesting
Culture of freshwater prawns: culture systems, rearing of grow outs and harvesting
Fresh water pearl culture: Biomineralization, Implantation Methods, Collection of mussels, Pre-operative conditioning, Mussel surgery, Post-operative care, Pond culture, Food and Feeding, Pearl harvest
Unit-III:
Microalgae:
Taxonomy of economically important micro algae.Distribution, morphology, reproduction, life cycle, growth physiology and Culture techniques and Importance of Spirulina & chlorella. Application of</td></tr>
</table>

	microalgae in waste water treatment as bioremediation **Unit-IV:** **Freshwater Vascular plants:** Taxonomy of economically important freshwater higher vascular plants. Distribution, morphology, reproduction, life cycle, growth physiology and Culture techniques of freshwater higher vascular plants (*Trapa, Typha*), Products of higher vascular plants, Reed bed technology in waste water treatment
Reference Books	1. Bardach, E.J. Rhyther, J.H. & W.O. Mc. Larney. (1972): Aquaculture. The Farming and Husbandry of freshwater and Marine Organisms. John Wiley and Sons. New York 2. FAO, (1992): Manual of seed production of carps 3. James, P McVey, (1983): Handbook of Mariculture, CRC press, Florida 4. Jhingran, V. G. (1991) Fish and Fisheries of India, Hindustan Publishers 5. Klontz, G.W., Downey, P.C. and Focht, R.L. (1979): A Manual for Trout and Salmon Production - The Sterling Cup Manual, University of Idaho, Moscow, ID. 6. Landau, M. (1992): Introduction to Aquaculture, John Wiley and Sons, New York. 7. Leitritz, E. and Lewis, R.C. (1984): Trout and Salmon Culture, State of California, Department of Fish and Game. 8. Mathew, L. (1992): Introduction to Aquaculture, John Wiley and Sons, INC, New York 9. Pillay, T.V.R. and Kutty, M.N. (2005): Aquaculture – Principles and Practices, Black Well Sciences, U.K. 10. Rath, R. K. (2000): Freshwater Aquaculture, Scientific Publishers, Jodhpur 11. Lewis Hansard Tiffany (1968): Algae the Grass of many waters. Blackwell scientific publications Ltd., Oxford. 12. Pixon, P.S. (1982): The Biology of Rhodophyta. Oliver and Boyd, Edinburgh. **13.** Round, F.E. (1981): The Ecology of the Algae, Cambridge University Press.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, ICT, Field visit

Evaluation Method	30% Internal assessment based on class attendance, assignment, internal examination, etc. 70% External based on University examination
Course Code	AQB: 304
Course Title	Marine Water Aquaculture
Credit	4
Teaching per week	4
Minimum weeks per semester	16
Effective from	June 2020
Purpose of course	The purpose of the course is to introduce to the students about different aquaculture technologies and methodsof finfishes, shellfishes and many other aquatic organism farming in the brackish water and marine water. The farming methods deal under this course certainly helpful to develop the entrepreneurship and employability among the participants.
Course objective	To introduce different technologies and farming methods of aquatic organism to harvest the aquatic resources.
Course outcome	CO1. The course regarding the brackish water aquaculture open the window of entrepreneurship for the students. CO2. This paper deals with the detail culture practices of the finfishes and shell fishes provide the detail idea about the culture and management of the coastal and marine resources. CO3. The shrimp aquaculture provide the better opportunity to use the existing resources and increase the employment and national income CO4. The marine aquaculture enhance the job opportunities, supports resilient working waterfronts and provide the opportunity in new national and international trading.
Mapping of COs with PSOs	
Course prerequisite	Specimens of fin fish, shell fish and sea weeds, models of fish farming systems
	Unit I (Hrs. 10) Brackish water finfish culture: Introduction, culture methods, harvesting and marketing of important Brackish water finfish (Mullet, Milk fish, Sea bass and peal spot) **Unit II (Hrs. 15) Shrimp culture:** Types of shrimps, Preparation and management of shrimp farm (pond preparation,seed selection and stocking,water quality, feeding, diseases, bio-security, harvesting and marketing). Effluent treatment plant in shrimp farming, Recent advances in shrimp farming (Two phase, Three phase, Race way culture,biofloc and RAS). **Unit III(Hrs. 12) Mari culture:** Introductions, types and advances in Mari culture. Edible oyster culture, Pearl oyster culture, techniques of pearl production,

	Lobster and Clam culture **Unit-IV (Hrs. 08) Marine water plants –Seaweeds:** Biodiversity of Seaweeds along the coast of India and Gujarat, Taxonomy of economically important seaweeds. Distribution, morphology, reproduction, life cycle, growth physiology andCulture techniques of sea weeds (*Gracilaria,Caulerpa*), Products from seaweeds.
References	1. Bardach, E.J. Rhyther, J.H. and W.O. McLarney (1972): Aquaculture. The Farming and Husbandry of freshwater and Marine Organisms. John Wiley and Sons. New York 2. Brown, E.E., Gratzek, J.B. (1980): Fish Farming Hand Book. AVI Publishing Company, West port USA 3. Fast, A.W. and Lester, L.J. (1992): Marine Shrimp culture – Principles and Practices. Elsvier Science Publishers, Amsterdams 4. James, P. McVey (1983): Handbook of Mariculture Vol. I. Crustacean Aquaculture. CRC Press. Inc. Florida; 442 pp. 5. Korring, P. (1976): Farming of marine fishes and shrimp. Elsvier Science Publishers, NY 6. Landau, M. (1992): Introduction to Aquaculture, John Wiley and Sons, New York. 7. Oren, O.H. (1981): Aquaculture of Grey Mullets. Cambridge University Press, London 8. Pillay, T.V.R. and Kutty, M.N. (2005): Aquaculture – Principles and Practices, Black Well Sciences, U.K. 9. Takeo, I. (1978): Aquaculture in shallow seas. Progress in shallow. Sea culture, Amerind Publishing Co. Pvt. Ltd. New Delhi. 613 pp. 10. Chapman, V.J. and Chapman, P.J. (1980): Seaweeds and their uses. Chapman and Hall with Methuen Inc., New York. 11. Dawson, R.Y (1966): Marine Botany. An Introduction Holt, Reinhart and Winston Inc., U.S.A. 12. Desikachary, T.V. (1975): Marine Plants. C.S.I.R., New Delhi. 13. Dring, M.J. (1982): The Biology of Marine Plants. Edward Arnold Publishers, London. 14. Kapraun, D.F. (1980): An illustrated guide to the benthic marine algae of coastal North Carolina- Rhodophyta. University North Carolina Press.
Teaching methods	Chalk and talk, Discussion, Videos, Self-study, Seminars and Assignments
Evaluation methods	Internal assessment (30%) based on the internal exam, attendance and assignments. External assessment (70%) based on the university examination at the end of the semester.

Course Code	305
Course Title	Fish physiology, Etiology and Fisheries technology
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per	15 (Including Classwork, examination, preparation, holidays etc.)

<table>
<tr><td>Semester</td><td></td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course is to develop concept and skill regarding fisheries technology and etiology used in aquaculture sector to manage aquatic resources.</td></tr>
<tr><td>Course Objective</td><td>To develop skill to find feeding, breeding, growth aspects of fishes.
To develop skill to identify diseases among fishes.
To develop concept about uses of technology for capture and culture fisheries as well as use of products and byproducts of fishery at commercial level.</td></tr>
<tr><td>Course Outcomes</td><td>CO 1:Aware about new emerging technologies for the development of fisheries and its application in the fisheries.
CO 2: Students will be able to develop skill to find feeding pattern of fish by dissectting buccal cavity and associate structures (Gill rackers, Buccopharynx), Gut content analysis and GaSI.
CO 3: Students will be able to develop skill to measure fecundity, egg diameter and gonadosomatic index, Age and Growth of fin fishes and shell fishes by using of scales and shells, biometry of fish.
CO 4: Students will be able to develop skill to estimate quantitative bacterial load in fish and isolate and identify pathogenic bacteria from fish with media preparation.
CO 5: Students will be able to identify diseases in fish.
CO 6: Gain knowledge of Remote sensing techniques, handling of gears and crafts and its application in fisheries.
CO 7: Analyzehematological parameters (RBC, WBC, Hemoglobin content, Hematocrit value) to know the health of the fishes.
CO 8: Gain knowledge of fishery products and byproducts and its application in commercial field.
CO 9: Gain practical experience through visit to fisheries Organizations / fish markets</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
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<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO7</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO9</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Biology</td></tr>
<tr><td>Course Content</td><td>

Study of buccal cavity and associate structures (Gill rackers, Buccopharynx)
Gut content analysis and GaSI
Measurement of fecundity, egg diameter and gonadosomatic index
Preparation of media
Quantitative estimation of bacterial load in fish

</td></tr>
</table>

	• Isolation and identification of pathogenic bacteria from fish • Study of diseased specimens • Determination of Age and Growth of fin fishes and shell fishes by means of scales and shells. • Biometry of fish • Study of Remote sensing techniques with the help of images. • Study of different gears and crafts(models/ drawing) • Study of hematological parameters (RBC, WBC, Hemoglobin content, Hematocrit value) • Study of fishery products and byproducts • Visit to fisheries Organizations / fish markets
Teaching Methodology	Classwork, Discussion, Self-Study, Practical, Demonstration, Field Visit, Institute visit
Evaluation Method	30% Internal assessment based on class attendance, internal examination, etc. 70% External based on University examination
Course Code	**306**
Course Title	Fisheries Technology and Aquaculture Management
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to make students capable of identifying and culture of aquatic organisms. The course will provide onsite experience of processing plants.
Course Objective	The objective of the course is to make the student capable to identify Sea weeds, fresh water higher vascular plants, aquatic insects, prawn larvae, seed stages, fin fishes, shell fishes, predatory and weed fishes. Students will learn about induced breeding and processing plants.
Course Outcomes	CO1: Students will be able to Identify Sea weeds, fresh water higher vascular plants, aquatic insects and prawn larvae, seed stages (eggs, spawns, fry and fingerlings), cultivable fin fishes, shell fishes, predatory and weed fishes. CO2: Gain insight on culture ofArtemia, Rotifers and Cladocerans CO3: Acquire knowledge on seeds production through Induced Breeding of Ornamental fish/ Catfishes CO4: Acquire skill for production of live feeds, seeds and microalgae in the field of Aquatic biology which can be helpful for entrepreneur and business development CO5: Gain onsite knowledge on processing plants/ hatcheries
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

	CO3						
	CO4						
	CO5						
Pre-requisite	Basics of biology and chemistry						
Course Content	• Identification fresh water higher vascular plants. • Identification of sea weeds • Identification of aquatic insects and prawn larvae. • Identification of seed stages (eggs, spawns, fry and fingerlings) • Identification of cultivable fin fishes, shell fishes, predatory and weed fishes. • Hatching and culturing of Artemia /Rotifier/cladocerans. • Induced Breeding and seed production of Ornamental fish/ Catfishes • Culture of Microalgae • Visit to processing plant/ hatcheries						
Reference Books	1. FAO, (1992): Manual of seed production of carps 2. Jhingran, V. G. (1991) Fish and Fisheries of India, Hindustan Publishers 3. Pillay, T.V.R. and Kutty, M.N. (2005): Aquaculture – Principles and Practices, Black Well Sciences, U. K 4. Talwar P.K, and Jhingran A.G (1991) Inland Fishes of India And Adjacent Countries Vol, Balkema, Rotterdam 5. Day, F. (1875-78). The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma andCeylon. Text and atlas in 4 parts. London, xx+ 778 pp., 195 pls.						
Teaching Methodology	Demonstration, Explanation, Practical, Discussion, Journal preparation						
Evaluation Method	30% Internal assessment based on class attendance, internal examination, etc. 70% External based on university examination						