Re-Accredited 'B++' 2.86 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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પરીપત્ર

The University Grants Commission (Minimum Standards and Procedures for Award of Ph.D. Degree) Regulations, 2022 ની જોગવાઈઓને અનુરૂપ પીએચ.ડી. કોર્ષવર્કના અભ્યાસક્રમને અદ્યતન કરવા અંગે એકવેટીક બાયોલોજી વિષયની RESEARCH AND RECOGNITION COMMITTEE ની તા.૧૮/૦૮/૨૦૨૫ ની સભાના ઠરાવ ક્રમાંક (૩) થી તૈયાર કરેલ આ સાથે સામેલ અભ્યાસક્રમને એકેડેમિક કાઉન્સિલે તેની તા.૧૧/૦૯/૨૦૨૫ ની સભાના ઠરાવ ક્રમાંક (૪) થી નીચે મુજબ મંજુર કરેલ છે. તદ્નુસાર ઘટતી કાર્યવાહી કરવાની જાણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૧૧/૦૯/૨૦૨૫ ની સભાનો ઠરાવ ક્રમાંક : (૪)

:: આથી ઠરાવવામાં આવે છે કે, એકવેટીક બાયોલોજી વિષયની RESEARCH AND RECOGNITION COMMITTEE ની તા.૧૮/૦૮/૨૦૨૫ ની સભાએ ઠરાવ ક્રમાંક : ૩ થી તૈયાર કરેલ અભ્યાસક્રમ મંજુર કરવામાં આવે છે.

કુલ સચિવ વતી

ક્રમાંક : પીએચ.ડી./કોર્ષવર્ક/૨૪૪૭૧/૨૦૨૫
તા.૧૫/૦૯/૨૦૨૫

પ્રતિ,

૧. તમામ કોલેજના આચાર્યશ્રીઓ, યુનિવર્સિટીના વિવિધ વિભાગોના વડાશ્રીઓ, યુનિવર્સિટી પરિસરના સ્વનિર્ભર અભ્યાસક્રમોના કો–ઓર્ડિનેટરશ્રીઓ, તમામ પીએચ.ડી.ના માર્ગદર્શક શિક્ષકશ્રીઓ તરફ જાણ તથા અમલ કરવા સારૂ...

૨. યુનિવર્સિટીના તમામ વહીવટી વિભાગોના વડાશ્રીઓ તરફ જાણ તથા જરૂરી કાર્યવાહી અંગે...

SYLLABUS

FOR

Ph.D. (Aquatic Biology) Course work

Submitted by

Department of Aquatic Biology
Veer Narmad South Gujarat University
Surat (Gujarat) 395 007

Ph.D. (Aquatic Biology)

Name of Program	**Master of Aquatic Biology**
Abbreviation	**AQB**
Duration	**6 Months (One Semester)**
Eligibility Criteria	A candidate who has obtained his/her Master's degree in science except maths and physics.
Objective of Program	The main objective of this programme is to prepare the students or scholars for research careers in aquatic resources management and sustainable utilization by providing an excellent teaching environment and research in the designed program. This structured programme will facilitate a career in various institutions i.e. education, research, industries, aquaculture farms, fisheries departments etc.
Program Outcome	**PO1: Basic Knowledge Enhancement** The designed program enhances students /scholars with basic knowledge of the subject matter to develop the research skills which include advance techniques of the laboratory, farm, field, disease management, feed technology, biochemistry, microbiological assessment, fish genetics, biotechnology and bioinformatics in the aquaculture. **PO2: Skill Development** The program develops the advance skills of aquatic resources management and the use of advance techniques and instruments to develop strategies of aquatic resources management. **PO3: Familiar with Advanced Emerging Technologies** The program trains students or scholars with the advanced technologies that being used in the research methodology, fisheries and aquatic pollution management. The designed syllabi enrich students with the technical aspects of identifying problems in the aquatic and natural environment. **PO4: Skill in analysis technique with Extension Education** The program is capable of preparing students/scholars to analyze and conceptualize real-world problems. It also enables students/scholars to understand the role of regulations in management of aquatic sources. **PO5: Research and Project Development The** Development of the factual project or research provides the learner's exposure to work in the demanding environment of extension, research, education and industry. The research and project development skills prepare students/scholars for an employable environment. **PO6: Group discussion, field visits, presentation, and confidence Development** The designed syllabi enable students/scholars to be group discussion, and sharing ideas. This also helps to enhance the confidence among the students/scholars. The healthy discussion in advanced technologies enables acquaintances of the students/scholars with the practical aspects.
Program Specific Outcomes	**PSO1:** Develop and strengthen the advanced knowledge and concepts that are required to manage aquatic resources. **PSO2:** Develop the professional skills to be confident in the research aspects. **PSO3:** Increase the capability of the student/scholar for handling instruments and use of the advanced technology to find remedial measures concerning aquatic sector. **PSO4:** Develop student/scholar for self-learning and challenging situations in aquatic sectors.

Mapping between POs and PSOs		PSO1	PSO2	PSO3	PSO4
	PO1				
	PO2				
	PO3				
	PO4				
	PO5				
	PO6				

Medium of Instruction	English
Programme structure	Semester-I

Theory Paper	Teaching schedule Hrs.	Exam Schedule				Total marks	Credit
		Internal exams		Internal exams			
		Mode of Evaluation	Marks	Mode of Evaluation	Marks		
AQB 1001: Research Methodology and publication Ethics	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
AQB 1002: Advances in Fishery Science	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
AQB 1003: Aquatic Pollution and sustainable water resource management	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
Total	**180**		**150**		**150**	**300**	**12**

Semester I

<table>
<tr><td>Course Code</td><td>AQB 1001</td></tr>
<tr><td>Course Title</td><td>Research methodology and Publication Ethics</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>2025-26</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of this course is to acquaint the knowledge on research methodology and publication ethics helps to problem selecting methods of the research. Students/scholars would be capable of drawing interferences of the research and write the scientific literatures.</td></tr>
<tr><td>Course Objective</td><td>To aware the students/ scholars about research methods, design and formulation along with skill of scientific writing.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: The application of different research methodology including sample collection and hypothesis formulation for research studies for research work and analysis
CO2: The course would help students to apply statistical analysis tools for the data analysis, interpretation and predict the outcomes of the research.
CO3: The course would help students capable of writing scientific literatures
CO4: It helps to aware the student to different tools and software that helps to identify the predatory publications and plagiarism.</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></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>CO3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</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 of Research Methodology: Introduction, Objectives of research, significance of research, type of research, Formulation & designing of research problem, sampling designing.
Data collection: Introduction, types of data and methods of data collection.
Introduction, format and different part or chapters in article / thesis.
Unit II
Methods for statistical Analyses
Hypothesis testing: Independent and Dependent sample ‘t’ test, Analysis of variance, Correlation and regression, Non parametric tests
Statistical Software: Introduction of SPSS, Microsoft Excel
Unit III
Philosophy and Ethics: Introduction, definition, nature and scope, concept branches, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific</td></tr>
</table>

	Misconducts (Falsification, Fabrication, and Plagiarism) and Redundant publications (duplicate and overlapping publication, salami slicing) Publication Ethics: definition, introduction, importance and Best practices (standards setting initiatives and guidelines). Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-versa, types. Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals and Predatory publishers and journal **Unit IV** Software tools: Software to identify predatory publications, plagiarism (Turnitin, Urkund etc.) and Journal finder/journal suggestion tools (JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.) Research Metrics: Impact factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score and Metrics (h-index, g index, i10 index, altmetrics) and Citation databases (Web of Science, Scopus, etc.)
Reference Books	1. Adil E. Shamoo; David B. Resnik (2003). Responsible Conduct of Research Oxford University Press, London. 2. Anderson B.H., Dursaton, and Poole M. (1997). Thesis and assignment writing, Wiley Eastern. 3. Bird, A. (2006). Philosophy of Science. Routledge. 4. Bordens K.S. and Abbott, B.B. (2008). Research Design and Methods, Mc Graw Hill. 5. Chaddah, P. (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarised. 6. Deakin, L. (2014). Best practice guidelines on publishing ethics: A publisher's perspective. Wiley. 7. Ethics in Science Education, Research and Governance Edited by Kambadur Muralidhar, Amit Ghosh Ashok Kumar Singhvi. (2008). Indian National Science Academy. 8. Graziano, A., M., and Raulin, M.L. (2007). Research Methods – A Process of Inquiry, Sixth Edition, Pearson. 9. Indian National Science Academy. (2019). Ethics in Science Education, Research and Governance. 10. Israel, M. (2015). Research ethics and integrity for social scientists: Beyond regulatory compliance. SAGE Publications. 11. Israel, M., & Hay, I. (2009). Research ethics for social scientists: Between ethical conduct and regulatory compliance. Sage. 12. Kimmel, A. J. (1988). Ethics and values in applied social research. Sage Publications. 13. Mertens, D. M., & Ginsberg, P. E. (2009). The handbook of social research ethics. Sage Publications. 14. Nicholas H. (2007). Introduction to the Responsible Conduct of Research. Office of Research Integrity. 15. Paul Oliver (2003). The Student's Guide to Research Ethics. Open University Press, 2003

	16. Resnik, D.B. (2011). What is Ethics in Research and why it is important? National Institute of Environmental Health Sciences. 17. Yadav, Santosh Kumar. (2000). Research and Publications Ethics. Ishwar Books.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, ICT
Evaluation Method	Internal assessment (50%): Exam (25) and Seminar (25) External assessment (50%): Based on university examination.

Ph.D. (Aquatic Biology)

Name of Program	**Master of Aquatic Biology**
Abbreviation	**AQB**
Duration	**6 Months (One Semester)**
Eligibility Criteria	A candidate who has obtained his/her Master's degree in science except maths and physics.
Objective of Program	The main objective of this programme is to prepare the students or scholars for research careers in aquatic resources management and sustainable utilization by providing an excellent teaching environment and research in the designed program. This structured programme will facilitate a career in various institutions i.e. education, research, industries, aquaculture farms, fisheries departments etc.
Program Outcome	**PO1: Basic Knowledge Enhancement** The designed program enhances students /scholars with basic knowledge of the subject matter to develop the research skills which include advance techniques of the laboratory, farm, field, disease management, feed technology, biochemistry, microbiological assessment, fish genetics, biotechnology and bioinformatics in the aquaculture. **PO2: Skill Development** The program develops the advance skills of aquatic resources management and the use of advance techniques and instruments to develop strategies of aquatic resources management. **PO3: Familiar with Advanced Emerging Technologies** The program trains students or scholars with the advanced technologies that being used in the research methodology, fisheries and aquatic pollution management. The designed syllabi enrich students with the technical aspects of identifying problems in the aquatic and natural environment. **PO4: Skill in analysis technique with Extension Education** The program is capable of preparing students/scholars to analyze and conceptualize real-world problems. It also enables students/scholars to understand the role of regulations in management of aquatic sources. **PO5: Research and Project Development The** Development of the factual project or research provides the learner's exposure to work in the demanding environment of extension, research, education and industry. The research and project development skills prepare students/scholars for an employable environment. **PO6: Group discussion, field visits, presentation, and confidence Development** The designed syllabi enable students/scholars to be group discussion, and sharing ideas. This also helps to enhance the confidence among the students/scholars. The healthy discussion in advanced technologies enables acquaintances of the students/scholars with the practical aspects.
Program Specific Outcomes	**PSO1:** Develop and strengthen the advanced knowledge and concepts that are required to manage aquatic resources. **PSO2:** Develop the professional skills to be confident in the research aspects. **PSO3:** Increase the capability of the student/scholar for handling instruments and use of the advanced technology to find remedial measures concerning aquatic sector. **PSO4:** Develop student/scholar for self-learning and challenging situations in aquatic sectors.

Mapping between POs and PSOs		PSO1	PSO2	PSO3	PSO4
	PO1				
	PO2				
	PO3				
	PO4				
	PO5				
	PO6				

Medium of Instruction	English
Programme structure	Semester-I

Theory Paper	Teaching schedule Hrs.	Exam Schedule				Total marks	Credit
		Internal exams		Internal exams			
		Mode of Evaluation	Marks	Mode of Evaluation	Marks		
AQB 1001: Research Methodology and publication Ethics	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
AQB 1002: Advances in Fishery Science	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
AQB 1003: Aquatic Pollution and sustainable water resource management	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
Total	**180**		**150**		**150**	**300**	**12**

Semester I

<table>
<tr><td>Course Code</td><td>AQB 1002</td></tr>
<tr><td>Course Title</td><td>AQB 1002: Advances in Fishery Science</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>2025-26</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of this course is to provide knowledge and skills in taxonomy, molecular biology techniques, bioinformatics and fish population studies for understanding biological systems.</td></tr>
<tr><td>Course Objective</td><td>The objective of this course is to provide students with knowledge and skills in molecular biology techniques, population studies, taxonomy and bioinformatics. It aims to develop their ability to analyse genetic and cellular processes, understand population dynamics, classify and identify organisms and apply computational tools for biological data analysis and phylogenetic studies.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will be able to explain the definitions, principles, practices, objectives and characteristics of taxonomy and demonstrate understanding of various approaches, advancements and its importance in biological sciences.
CO2: Students will be able to elucidate principles, methods and applications of molecular biology techniques like cryopreservation, sex-reversal, chromosomal manipulation and transgenesis for increasing aquaculture production by genetically modifying aquatic organisms and fish population management.
CO3: Students will be able to understand the fundamental concepts of Bioinformatics and its various branches, differentiate between Bioinformatics and Computational Biology and illustrate genomics as well as protein sequence databases.
CO4: The course acquaints students' knowledge about principles of fish population dynamics and analyse fish stock structure through age, length and sex composition studies. Students are capable to estimate population size using appropriate tools and models for sustainable fisheries management.</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></tr>
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</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basics of biology and chemistry</td></tr>
<tr><td>Course Content</td><td>Unit I
Taxonomy: Introduction, objectives, principles, practices, characteristics importance and function.
Approaches in taxonomy: Embryological, anatomical, biochemical, ecological and ethological.</td></tr>
</table>

	Advances in taxonomy: Molecular taxonomy, DNA bar coding, Nucleic acid hybridization and Ribosomal RNA homology. Taxonomy and conservation: Political and economic issues in fish biodiversity, Biotechnological fish conservation. National programmes on fish conservation. **Unit II** Cryopreservation: Introduction, principle, methods, advantages, limitations and application in aquaculture. Introduction and importance of sperm bank. Sex reversal: Introduction, methods, application, advantages and limitations. Introduction and dosage of hormones in sex differentiation. Chromosomal manipulation: gynogenesis and androgenesis - Introduction, methods, application, advantages and limitations. Transgenesis: Introduction, concept, methods of gene transfer, advantages, limitations and application in aquaculture. Regulatory guidelines for ethical concerns in sex reversal, chromosomal manipulation and transgenesis. **Unit III** Bioinformatics and Computational biology: Introduction, scope, concepts, application and branches. Bioinformatics versus computational biology. Genomics: Introduction and tools in fisheries. Protein Databases: Introduction, application and different formats of databases. **Unit IV** Fish population dynamics: Introduction, principles and tools. Fish stock assessments: Age-length and sex composition, estimation of population size and population models.
Reference Books	1. Agostino, M. (2012). Practical Bioinformatics. Garland Science eBooks. 2. Aoki, I., Yamakawa, T. and Takasuka, A. (2018). Fish Population Dynamics, Monitoring, and Management. Springer. 3. Benjamin, L. (2008). GENES- IX. Jones and Bartlett Publishers. 4. Betsy, J. and Kumar, S. (2021). Cryopreservation of Fish Gametes. Springer. 5. Cleveland P. Hickman, Jr., Larry S. Roberts, Susan L. Keen, David J. Eisenhour, Allan Larson, Helen l'Anson, (2014). Integrated Principles of Zoology, 16th Ed., McGraw Hill Education. 6. Crawley, Michael J. (2013). The R book. John Wiley & Sons Ltd, Chichester, West Sussex PO19 8SQ, United Kingdom. 7. Gupta, S. K. and Gupta, P. C. (2002). General and Applied Ichthyology (Fish and Fisheries). S. Chand and Company, New Delhi. 8. Jayakumar, N. Durairaja, R. Jawahar, P. and Felix, S. (2021). Fish Population Dynamics and Stock Assessment. Daya Publishing House. 9. Kar, D. K. and Halder, S. (2009). Cell Biology Genetics Molecular Biology. New Central Book Agency, Kolkata.

	10. Lakra, W. S. (2000). Fish Genetics and Biotechnology. CIFE, Mumbai. 11. Lakra, W. S., Abidi, S. A. H., Mukherjee, S. C. and Ayyappan, S. (2004). Fisheries Biotechnology. Narendra Publishing House. 12. Lodish, H., Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M., Scott, M. P. and Lutz, C. G. (2003). Practical Genetics for Aquaculture. Wiley-Blackwell. 13. Malvee, S. (2008). Fish Genetics, SBS Publishers, New Delhi. 14. Nagabhushanam, R., Diwan, A. D. and Gyananath, G. (2009). Biotechnology Fundamentals and Applications. Narendra Publishing House, Delhi, India. 15. Simpson, G.G. (2024). Principles of Animal Taxonomy, 1st Ed. Scientific Publishers.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, ICT
Evaluation Method	Internal assessment (50%): Exam (25) and Seminar (25) External assessment (50%): Based on university examination.

Ph.D. (Aquatic Biology)

Name of Program	**Master of Aquatic Biology**
Abbreviation	**AQB**
Duration	**6 Months (One Semester)**
Eligibility Criteria	A candidate who has obtained his/her Master's degree in science except maths and physics.
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Program Outcome	**PO1: Basic Knowledge Enhancement** The designed program enhances students /scholars with basic knowledge of the subject matter to develop the research skills which include advance techniques of the laboratory, farm, field, disease management, feed technology, biochemistry, microbiological assessment, fish genetics, biotechnology and bioinformatics in the aquaculture. **PO2: Skill Development** The program develops the advance skills of aquatic resources management and the use of advance techniques and instruments to develop strategies of aquatic resources management. **PO3: Familiar with Advanced Emerging Technologies** The program trains students or scholars with the advanced technologies that being used in the research methodology, fisheries and aquatic pollution management. The designed syllabi enrich students with the technical aspects of identifying problems in the aquatic and natural environment. **PO4: Skill in analysis technique with Extension Education** The program is capable of preparing students/scholars to analyze and conceptualize real-world problems. It also enables students/scholars to understand the role of regulations in management of aquatic sources. **PO5: Research and Project Development The** Development of the factual project or research provides the learner's exposure to work in the demanding environment of extension, research, education and industry. The research and project development skills prepare students/scholars for an employable environment. **PO6: Group discussion, field visits, presentation, and confidence Development** The designed syllabi enable students/scholars to be group discussion, and sharing ideas. This also helps to enhance the confidence among the students/scholars. The healthy discussion in advanced technologies enables acquaintances of the students/scholars with the practical aspects.
Program Specific Outcomes	**PSO1:** Develop and strengthen the advanced knowledge and concepts that are required to manage aquatic resources. **PSO2:** Develop the professional skills to be confident in the research aspects. **PSO3:** Increase the capability of the student/scholar for handling instruments and use of the advanced technology to find remedial measures concerning aquatic sector. **PSO4:** Develop student/scholar for self-learning and challenging situations in aquatic sectors.

Mapping between POs and PSOs		PSO1	PSO2	PSO3	PSO4
	PO1				
	PO2				
	PO3				
	PO4				
	PO5				
	PO6				

Medium of Instruction	English						
Programme structure	Semester-I						
Theory Paper	Teaching schedule Hrs.	Exam Schedule				Total marks	Credit
		Internal exams		Internal exams			
		Mode of Evaluation	Marks	Mode of Evaluation	Marks		
AQB 1001: Research Methodology and publication Ethics	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
AQB 1002: Advances in Fishery Science	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
AQB 1003: Aquatic Pollution and sustainable water resource management	60	Exams and seminar	(25+ 25) 50	Exam conducted by the university	50	100	04
Total	**180**		**150**		**150**	**300**	**12**

Semester I

<table>
<tr><td>Course Code</td><td>AQB 1003</td></tr>
<tr><td>Course Title</td><td>Aquatic Pollution and sustainable water resource 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>2025-26</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of this course is to acquaint the knowledge on aquatic pollution for sustainable water resource management. Students/scholars would be capable to know the pollution related problems of water resources and their management for optimum utilization of aquatic resources.</td></tr>
<tr><td>Course Objective</td><td>To enable the students/ scholars about aquatic pollution for sustainable water resource management and optimum utilization.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will be able to remember and define the principles of water quality evaluation, and their effects, understand global and national regulatory frameworks, and sustainable water management principles
CO2: Students will be capable of applying scientific procedures for sampling and preserving water, sediment, and biota; applying biodiversity indices in measuring water quality; and shall be capable of applying conventional and new treatment technologies, as well as GIS/remote sensing tools for monitoring pollution.
CO3: Students will be capable of analyzing the interactions among contaminants in aquatic environments and comparing the efficiency, effectiveness, and sustainability of traditional and innovative decontamination technologies.
CO4: Students will be able to evaluate ecological hazard induced by pollution, make decisions on the effectiveness of regulation requirements, monitoring systems, and legislation.
CO5: Students will be capable of designing and establishing integrated water quality monitoring frameworks; formulating sustainable water management plans; and providing innovative solutions against emergent pollutants using existing technologies.</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></tr>
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<tr><td>CO2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</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: Water Pollution Assessment
Sampling and Preservation Methods: Physico-chemical water quality parameters and Microbial sampling (protocols and preservation), Sediment and biota collection techniques</td></tr>
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	Identification and Analysis of Pollutants: Point and non-point pollution sources, Detection of organic, inorganic, microbial pollutants and emerging contaminants (microplastics, pharmaceuticals and heavy metals). Biological Indicators and Biodiversity Indices: Use of bioindicators (algae, invertebrates, fish), Algal indices (Nygaard's and Palmer's indices), Biodiversity Indices (Shannon-Wiener, Simpson's index and Sequential Comparison Index). Advanced Analytical Tools: Molecular markers for microbial source tracking, GIS and remote sensing in water quality assessment, Advances in MPN techniques. **Unit II: Ecological Impact of Aquatic Pollution** Ecosystem-Specific Pollution Impacts: Pollution in Rivers, lakes, and marine ecosystems. Impacts on Aquatic Biota: Pollution induced changes in phytoplankton, zooplankton, vascular plants, invertebrates and fish. Sediment Interactions and Benthic Systems: Toxicant adsorption/desorption in sediments, Bioavailability and benthic toxicity pathways. Special Phenomena and Effects: Algal blooms, eutrophication, Biomagnification, bioaccumulation, Ballast water discharge and aquatic invasions. **Unit III: Waterborne Diseases and Regulatory Frameworks** Waterborne Diseases and Public Health: Classification of pathogens and transmission pathways, antibiotic resistance, epidemiological surveillance. Water Decontamination Technologies: Conventional (chlorination, UV, ozonation, filtration) and Advanced (membrane technologies, AOPs, nanotech-based treatments). Water Quality Standards and Legislation: WHO, BIS, CPCB, EPA guidelines, Regulatory acts (Water Act 1974, Environment Protection Act 1986), Role of global treaties and international collaborations. **Unit IV: Sustainable Water Management and Pollution Control Strategies** Water and Sewage Purification Systems: Water Treatment Plant, Sewage Treatment Plant, Decentralised Wastewater Treatment Systems (DEWATS). Point and Non-Point Source Pollution Control: Source identification and mapping using GIS/remote sensing, Agricultural, industrial, and domestic sources, Best Management Practices (BMPs). Water Conservation and Recycling Approaches: Integrated Water Resource Management (IWRM), rainwater harvesting, Agricultural water efficiency (drip, precision farming), Industrial solutions (Zero Liquid Discharge (ZLD), water footprint analysis). Desalination Technologies: Reverse osmosis and other methods [Multi-Stage Flash Distillation (MSF), Electrodialysis Reversal

	(EDR)], Economic and environmental feasibility, Policy and regulatory considerations.
Reference Books	1. APHA (American Public Health Association). (2023). *Standard methods for the examination of water and wastewater* (24th Ed.). Washington, DC: APHA-AWWA-WEF. 2. Bureau of Indian Standards (BIS). (2012). *Indian standard drinking water—specification (IS 10500:2012)*. New Delhi: Bureau of Indian Standards. 3. Central Pollution Control Board (CPCB). (2008). *Guidelines for water quality monitoring*. New Delhi: Ministry of Environment, Forest and Climate Change, Government of India. 4. Chapman, D. (1996). *Water Quality Assessments – A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring*. WHO/UNEP. 5. Goel, P. K. (2006). *Water pollution: Causes, effects and control* (2nd ed.). New Delhi: New Age International Publishers. 6. Kaushik, A., & Kaushik, C. P. (2019). *Perspectives in environmental studies* (6th Ed.). New Delhi: New Age International Publishers. 7. Khopkar, S. M. (2004). *Environmental pollution analysis*. New Delhi: New Age International Publishers. 8. Pande, S. P., & Sharma, A. (1999). *Water pollution: Causes, effects and control*. New Delhi: Sarup & Sons. 9. Sharma, P. D. (2010). *Ecology and environment* (10th ed.). Meerut: Rastogi Publications. 10. Trivedy, R. K., & Goel, P. K. (1986). *Chemical and biological methods for water pollution studies*. Karad: Environmental Publications. 11. UNEP (2021). *Progress on Water-related Ecosystems: Global Report.* 12. World Health Organisation (WHO). (2017). *Guidelines for drinking-water quality* (4th ed., incorporating the 1st addendum). Geneva: World Health Organization.
Teaching Methodology	Classwork, Discussion, Self-Study, Assignment, ICT
Evaluation Method	Internal assessment (50%): Exam (25) and Seminar (25) External assessment (50%): Based on university examination.