



**SIES**

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

*(Affiliated to University of Mumbai)*

AC/27.6.23/RS 2

College of Arts,  
Science &  
Commerce (Autonomous)

**Faculty: Science**

**Program: M.Sc. - II**

**Subject: ZOOLOGY**

**Specialization: Oceanography and Fishery Science**

**Academic Year: 2023 – 2024**

**Revised Syllabus under Choice Based Credit System (CBCS)**

**Approved by the Board of Studies in Zoology**

**Effective from Academic year: 2023-24**

### **Preamble**

*“The sea, the great unifier, is man's only hope. Now, as never before, the old phrase has a literal meaning: we are all in the same boat” – Jacques Yves Cousteau (1910-1997; French Oceanographer, Filmmaker, Writer who co-invented the first successful Aqua-Lung, SCUBA: self-contained underwater breathing apparatus)*

*Under the aegis of academic autonomy, the Department of Zoology has the privilege of ‘academic freedom’ to revise its course and curriculum, however, it is also aware of the fact that ‘academic freedom’ needs to be justified with ‘academic excellence’. One of the ways to achieve this is through fine-tuning the curriculum. As students at the postgraduate level would have a foundation of the basics of the subject, this syllabus focuses on the need to furnish them with skills and understanding essential to make them self-sufficient and build a future.*

*Some of the key features of this revised syllabus are as follows:*

- ✓ *Physical, Chemical and Biological Oceanography – to familiarize students the nature of life in the sea and our relationship to that life; to familiarize students with physical aspects of Oceanography such as tides, waves and currents that not only influence aquatic life but also life on the terrestrial realm.*
- ✓ *Aquaculture – to introduce to the students the field of aquaculture and know its immense potential for generating employment; to acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit; to consider aquaculture as a subsidiary in the income of someone having a taste for it and also to inculcate an entrepreneurial culture.*
- ✓ *Fishery Science and Fish Processing Technology – to impart knowledge of the vast array of opportunities offered by Fish processing industry by acquainting them to various methods of fish processing; to make the students familiar and get acquainted with different methods and materials required in traditional and recent methods in fish processing*
- ✓ *Marine Biotechnology, Toxicology and Fish pathology – to make the students understand the principles of toxicology, various toxicants, and their effects with reference to marine environment; to familiarize learners with promising marine bioactive compounds and their immense potential in various fields of sciences; to have knowledge about various finfish diseases and the diagnostic techniques for their detection*
- ✓ *Marine Biodiversity Conservation, EIA and CRZ – to make the students aware of the fact that the ultimate measure of our wisdom in managing the environment of our planet will be, how well we have collectively done in maintaining the biodiversity and unique character of life in our oceans.*
- ✓ *Industry Internship – to strengthen academia-industry linkage and to increase employability of students, to give students structured training for exposure to working environment so as to combine experiential learning with theoretical concepts.*
- ✓ *Research project/Dissertation – to inculcate research aptitude and to develop an open, inquiring mind that is willing to explore new territories and learn new things; to encourage the spirit of curiosity of students, who are not just learners but also potential problem solvers and scientific investigators.*

*Considering the overarching influence of tools and techniques in biological sciences, educationists need to understand that students need to inculcate an interdisciplinary approach in understanding and contemplating pure sciences. In this context, the revised syllabus is an arena for students to explore the bridge between science and society. It is indeed reflected in the contents and topics introduced in this revised syllabus, thanks to the collective and constructive efforts of the members of the board of studies comprising distinguished faculty, experts from industry/allied area and research institutions. The valuable comments, suggestions and recommendations of the contributors and reviewers have been carefully considered and implemented wherever feasible.*

*For effective teaching learning, teachers are advised not to follow the syllabus too rigidly, but to exercise their professional discretion and judgement in implementing it. After all teaching is about creating a conducive environment for learners to sustain enthusiasm about the subject. The revised syllabus will encourage critical thinking, instil analytical skills, besides inculcating interdisciplinary approach amongst student’s to make learning more meaningful, thereby pursuing academic excellence. Thus, we have made a modest attempt towards maximizing learning by designing an effective syllabus. We sincerely hope that all stakeholders from faculty to learners exploring this course will appreciate the importance of a well-designed curricular framework in shaping educational outcomes.*

*Dr. Satish Sarfare*

*Chairman, Board of Studies in the subject of Zoology*

*SIES College of Arts, Science and Commerce (Autonomous)*

*Sion (West), Mumbai; Email: [satishs@sies.edu.in](mailto:satishs@sies.edu.in)*

***Members of the Board of Studies in the subject of Zoology and Syllabus Committee***

- ✓ *Professor (Dr.) Manisha Kulkarni – Department of Zoology, Institute of Science, Fort, Mumbai (Vice Chancellor's Nominee)*
- ✓ *Professor (Dr.) Manoj Mahimkar – Principal Investigator, Cancer Research Institute, ACTREC, Kharghar, Navi Mumbai; (Subject expert from outside the Parent University to be nominated by the Academic Council)*
- ✓ *Dr. Sasikumar Menon – Director, Institute for Advanced Training & Research in Interdisciplinary Sciences (IATRIS), (Therapeutic Drug Monitoring Lab), Sion, Mumbai; Faculty, Pharma Analytical Sciences, Ruia College, Mumbai (Subject Expert from outside college/Industry expert)*
- ✓ *Mr. Kedar Gore – Director, The Corbett Foundation (Non-profit Organization), Mumbai, (Subject expert from outside college / Representative from Corporate sector / Allied area)*
- ✓ *Ms. Uma Bandekar – Clinical Team Manager with ICON plc (Postgraduate Meritorious Alumnus)*
- ✓ *Mr. Pushparaj Shetty – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Rupali Vaity – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Madhavan Gopalan – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Aditya Akerkar – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Mr. Prathamesh Kulkarni – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Sharvari Kudtarkar – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Satish Sarfare – Head and Faculty, Department of Zoology, SIES College, Mumbai*

**M.Sc. Part II – Zoology (Oceanography and Fishery Science) syllabus-Semester III**  
**Approved by the Board of Studies in Zoology effective from Academic year: 2023-24**

<b>THEORY</b>				
<b>Course name/code</b>	<b>Unit</b>	<b>Topic Headings</b>	<b>Credits</b>	<b>Lectures / week</b>
<b>SEMESTER III</b>				
<b>Paper I: General, Physical, Chemical and Biological Oceanography</b>				
<b>SIPSZOOCN31</b>	1	General Oceanography	<b>4</b>	<b>1</b>
	2	Physical Oceanography		<b>1</b>
	3	Chemical Oceanography		<b>1</b>
	4	Biological Oceanography		<b>1</b>
<b>Paper II: Aquaculture</b>				
<b>SIPSZOOCN32</b>	1	Introduction to Aquaculture	<b>4</b>	<b>1</b>
	2	Shellfish culture		<b>1</b>
	3	Fin Fish and other cultures		<b>1</b>
	4	Marketing and Finance		<b>1</b>
<b>Paper III: Fish processing technology:</b>				
<b>SIPSZOOCN33</b>	1	Logistics in fish processing	<b>4</b>	<b>1</b>
	2	Traditional fish processing		<b>1</b>
	3	Modern fish processing		<b>1</b>
	4	Quality assurance norms and methods		<b>1</b>
<b>Paper IV: Industry Internship/Training</b>				
<b>SIPSZOOCN34</b>		<b>Industry Internship/Training</b>	<b>4</b>	<b>4</b>
<b>PRACTICAL</b>				
<b>SIPSZOOCNP31</b>		Based on <b>SIPSZOOCN31</b>	<b>2</b>	<b>4</b>
<b>SIPSZOOCNP32</b>		Based on <b>SIPSZOOCN32</b>	<b>2</b>	<b>4</b>
<b>SIPSZOOCNP33</b>		Based on <b>SIPSZOOCN33</b>	<b>2</b>	<b>4</b>
<b>SIPSZOOCNP34</b>		Based on <b>SIPSZOOCN34</b>	<b>2</b>	<b>4</b>
		<b>Total</b>	<b>24</b>	<b>32</b>

**M.Sc. Part II – Zoology (Oceanography and Fishery Science) syllabus-Semester IV**  
**Approved by the Board of Studies in Zoology effective from Academic year: 2023-24**

<b>THEORY</b>				
<b>Course name/ code</b>	<b>Unit</b>	<b>Topic Headings</b>	<b>Credits</b>	<b>Lectures /week</b>
<b>SEMESTER IV</b>				
<b>Paper I: Fishery Science</b>				
<b>SIPSZOOCN41</b>	1	Marine finfish resources in Pelagic and Demersal systems	<b>4</b>	<b>1</b>
	2	Marine Shellfish resources in Pelagic and Demersal systems		<b>1</b>
	3	Trophodynamics in aquatic systems		<b>1</b>
	4	Marine fishery- Economics and Conservation		<b>1</b>
<b>Paper I: Marine Biotechnology, Toxicology and Fish pathology</b>				
<b>SIPSZOOCN42</b>	1	Marine Biotechnology	<b>4</b>	<b>1</b>
	2	Marine Bioactive Compounds		<b>1</b>
	3	Marine toxicology		<b>1</b>
	4	Fish pathology		<b>1</b>
<b>Paper III: Marine Biodiversity Conservation, EIA and CRZ</b>				
<b>SIPSZOOCN43</b>	1	Marine Biodiversity- Mangroves, Corals, Marine Birds, marine Mammals, marine reptiles, and their Conservation	<b>4</b>	<b>1</b>
	2	Marine Biodiversity Conservation laws and marine protected areas of India		<b>1</b>
	3	Environmental impact assessment and Coastal regulatory Zone		<b>1</b>
	4	Ocean policies and Management		<b>1</b>
<b>Paper IV: Research Project/Dissertation</b>				
<b>SIPSZOOCN44</b>		<b>Research Project/Dissertation</b>	<b>4</b>	<b>4</b>
<b>PRACTICAL</b>				
<b>SIPSZOOCNP41</b>		Based on <b>SIPSZOOCN41</b>	<b>2</b>	<b>4</b>
<b>SIPSZOOCNP42</b>		Based on <b>SIPSZOOCN42</b>	<b>2</b>	<b>4</b>
<b>SIPSZOOCNP43</b>		Based on <b>SIPSZOOCN43</b>	<b>2</b>	<b>4</b>
<b>SIPSZOOCNP44</b>		Based on <b>SIPSZOOCN44</b>	<b>2</b>	<b>4</b>
		<b>Total</b>	<b>24</b>	<b>32</b>

**SIES College of Arts, Science and Commerce (Autonomous)Sion  
(West), Mumbai – 400 022**

**Programme: Master of Science, M.Sc. Part 2 – Zoology**

*“That is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer.”  
- Jacob Bronowski*

The characteristic Post-graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science post graduate in the subject of Zoology are as follows:

**Note the list of abbreviations:**

*PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome*

*Cognitive Levels: R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create*

Serial Number	Details of Programme Outcomes (POs)
PO1 (Skill Level)	<p><b><u>Problem Solving Ability (U, Ap)</u></b></p> <ul style="list-style-type: none"> <li>● Apply the knowledge of various courses learned under a program to break down complex problems into simple components.</li> <li>● Adopt and assimilate problem-based learning models and apply one’s learning to solve real life problem situations.</li> </ul>
PO2 (Skill Level)	<p><b><u>Critical Thinking (U, An, E)</u></b></p> <ul style="list-style-type: none"> <li>● Develop critical thinking based on a rationale to identify assumptions, verifying the accuracy and validity of assumptions, and making informed decisions.</li> <li>● Inculcate the ability of logical reasoning to question the rationale behind concepts, ideas, and perspectives.</li> </ul>
PO3 (Skill Level)	<p><b><u>Effective Communication Skills (Ap, C)</u></b></p> <ul style="list-style-type: none"> <li>● Improve written and oral communication skills so as to express thoughts and ideas effectively.</li> <li>● Demonstrate the ability to listen carefully and imbibe soft skills to convey and receive instructions clearly.</li> <li>● Develop presentation skills to present complex information in a clear, lucid and concise manner.</li> </ul>
PO4 (Skill Level)	<p><b><u>Proficiency with Information and Communication Technology (U, An, E)</u></b></p> <ul style="list-style-type: none"> <li>● Demonstrate ability to access, evaluate and use a variety of relevant information resources inclusive of internet and electronic media for the purpose of collating and analyzing data.</li> <li>● Understand the scope and limitations of tools or software used in Information and Communication Technology.</li> </ul>
PO5 (Skill Level)	<p><b><u>Leadership Skills and Team Work (U, Ap, An, C)</u></b></p> <ul style="list-style-type: none"> <li>● Demonstrate leadership skills formulating an inspiring vision, thereby building a team, motivating and inspiring team members to engage and achieve that vision.</li> <li>● Develop management skills to guide people in taking tasks to their logical conclusion.</li> <li>● Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognize the contribution of team members.</li> </ul>
PO6 (Attitude Level)	<p><b><u>Self-directed and Lifelong Learning (U, Ap, An)</u></b></p> <ul style="list-style-type: none"> <li>● Demonstrate the ability to work independently and take responsibility for one’s actions.</li> <li>● Acquire the ability to explore and evolve by becoming self-sufficient and self-reliant.</li> <li>● Adapt lifelong learning approaches to broaden one’s horizons for personal growth</li> </ul>
PO7 (Attitude Level)	<p><b><u>Ethical Values and Environmental Concerns (U, Ap, E)</u></b></p> <ul style="list-style-type: none"> <li>● Embrace moral or ethical values in conducting one’s life and implement ethical practices in all aspects of life.</li> <li>● Create awareness and concern for environmental and sustainability issues.</li> <li>● Understand and realize the significance and relevance of co-habitation and co-evolution in attaining the needs of sustainable development.</li> </ul>

PO8 (AttitudeLevel)	<p>Gender Sensitization and Community Service (<i>U, Ap, An</i>)</p> <ul style="list-style-type: none"> <li>• Respect gender sensitivity, gender equity and gender justice.</li> <li>• Encourage mutual understanding and express empathetic social concern towards different value systems and different strata of society.</li> <li>• Engage in community service through Institutional Social Responsibility.</li> </ul>
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Serial Number	Details of Programme Specific Outcomes (PSOs) (Oceanography and Fishery Science)
PSO1	<p><b><u>Conceptual Understanding and Emerging Applications (<i>R, U, Ap, An</i>)</u></b></p> <ul style="list-style-type: none"> <li>• Inculcate conceptual and coherent understanding of Oceanography and Fishery Science, and demonstrate a broad understanding of different aspects of Oceanography and to learn about the general features of the earth's surface under water.</li> <li>• Understand the in-depth concepts of different areas of Oceanography and Fishery science such as, Aquaculture, Fish processing technology, Marine Biotechnology, Marine Toxicology, Fish Pathology, Marine Biodiversity and Conservation, so as to recognize the current scenario and apply appropriate methodologies with cutting edge tools/techniques to seek solutions to emerging problems faced by mankind.</li> <li>• Demonstrate the relevance of the procedural subject knowledge that creates different types of professionals related to the disciplinary/subject area of zoology, including professionals engaged in research and development, teaching and government/public service.</li> </ul>
PSO2	<p><b><u>Analytical reasoning and Scientific Inquiry (<i>U, An, E</i>)</u></b></p> <ul style="list-style-type: none"> <li>• Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions.</li> <li>• Encourage the ability to analyze, interpret and draw conclusions from qualitative/quantitative data and critically evaluate ideas, experiences, theories and concepts by following scientific approach to knowledge development from an open minded and reasoned perspective.</li> <li>• Develop analytical skills involving paying attention to detail and imbibe the ability to construct logical arguments using correct technical language related to the relevant subject.</li> <li>• Analyze and interpret data/information collected or related to experiments or investigations, using appropriate methods involving Biostatistics, Bioinformatics among others and report accurately the findings of the experiment/investigations while relating the conclusions/ findings to relevant theories of zoology.</li> </ul>
PSO3	<p><b><u>Laboratory Skills and Fieldwork (<i>R, U, E, C</i>)</u></b></p> <ul style="list-style-type: none"> <li>• Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for successful career in teaching, research, industry, etc.</li> <li>• Demonstrate awareness regarding animal ethics, human ethics, conservation of flora and fauna, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge.</li> </ul>
PSO4	<p><b><u>Research Aptitude and Interdisciplinary Approach (<i>Ap, An, E, C</i>)</u></b></p> <ul style="list-style-type: none"> <li>• Inculcate and adapt to research aptitude and culture, integrate research-based knowledge in an interdisciplinary framework, and realize the relevance of choosing research as an alternative career option.</li> <li>• Demonstrate the awareness regarding compliance with research ethics, awareness about conflicts of interests and Intellectual Property Rights, and avoiding unethical behavior such as fabricating, falsifying, or misrepresenting data or to committing plagiarism.</li> <li>• Inculcate the ability to recognize cause and effect relationships, formulate hypothesis, reporting the results of an experiment or investigation, and application of research tools for analysis and interpretation of data.</li> <li>• Inculcate an interdisciplinary approach, to understand and consolidate fundamental concepts through inquiry-based curriculum, develop critical thinking and problem-solving ability required to solve different types of biology related problems with well-defined solutions, and tackle open-ended problems that may cross disciplinary-area boundaries.</li> </ul>

## Course Outcomes for M.Sc. Part 2

### At the root of all (science) education (Core Learning Outcome):

“The imaginative and original mind need not be overawed by the imposing body of present knowledge or by the complex and costly paraphernalia which today surround much of scientific activity. The great shortage in science now is not opportunity, manpower, money, or laboratory space. What is really needed is more of that healthy skepticism which generates the key idea – the liberating concept.”– *P.H. Abelson*

Purity of mind leads to clarity in thought and action for creation of an original archaic work. As well, to consciously attempt the basic pursuit of understanding human existence.

<b><u>Oceanography and Fishery Science</u></b>		
<b><u>Semester III – Theory</u></b>		
<b>Course Code: SIPSZOOCN31</b>		
<b>Course Name: General, Physical, Chemical and Biological Oceanography</b>		
The study of this course will accomplish the following outcomes:		
<b>Unit 1: General Oceanography</b>		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO1:</b> <ul style="list-style-type: none"> <li>• To give a brief introduction to acquaint students with the different aspects of Oceanography.</li> <li>• To appreciate the monumental events in the history of oceanography that have influenced the current understanding of the subject.</li> <li>• To get acquainted to ship-building, tools used for oceanographic studies and research in order to inculcate research and application-based attitude.</li> <li>• To learn about the general features of the earth’s surface under water with reference to the ocean waters of the Indian subcontinent.</li> </ul>	<i>R, U</i>	<i>PO2, PO4, PO6, PO7</i>  <i>PSO1</i>
<b>Unit 2: Physical Oceanography</b>		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO2:</b> <ul style="list-style-type: none"> <li>• To analyze the physical attributes of sea water and comprehend their influence on aquatic life</li> <li>• To throw light on ocean circulation – a key regulator of climatic changes.</li> <li>• To get acquainted to phenomena regulating the global climate.</li> </ul>	<i>R, U, An</i>	<i>PO2, PO4, PO6, PO7</i>  <i>PSO1, PSO2</i>
<b>Unit 3: Chemical Oceanography</b>		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO3:</b> <ul style="list-style-type: none"> <li>• To study inorganic constituents – the chemicals that make up the ocean and their role in nurturing oceanic life.</li> <li>• To study the role of dissolved gases and nutrients in marine environment, their availability, distribution in order to appreciate the influence of these factors on aquatic as well as terrestrial life</li> <li>• To value the mineral resources those are obtained from the oceans and their large-scale applications.</li> </ul>	<i>R, U, An</i>	<i>PO2, PO4, PO6, PO7</i>  <i>PSO1, PSO2</i>
<b>Unit 4: Biological Oceanography</b>		



Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO4:</b> <ul style="list-style-type: none"> <li>To understand the extent and division of marine environment owing to prevalent physical factors and to analyze their influence on marine biotic diversity</li> <li>To appreciate the vast array of marine biotic diversity from plankton to large nekton.</li> <li>To get enlightened by the plethora of adaptations and associations exhibited by varied marine organisms with changing climatic conditions so as to draw appropriate conservation measures.</li> </ul>	<i>R, U</i>	<i>PO2, PO4, PO6, PO7</i>  <i>PSO1, PSO2</i>

<b>Course Code: SIPSZOOCN32</b> <b>Course Name: Aquaculture</b> The study of this course will accomplish the following outcomes:		
<b>Unit 1: Introduction to Aquaculture</b>		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO1:</b> <ul style="list-style-type: none"> <li>To introduce aquaculture to know its immense potential for generating employment</li> <li>To acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit.</li> <li>To consider aquaculture as a subsidiary in the income of someone having a taste for it.</li> <li>To attain a clear perception of the present status of sea farming in India and to compare it with worldwide production and trends</li> <li>To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems.</li> </ul>	<i>R, U</i>	<i>PO2, PO4, PO6, PO7, PO8</i>  <i>PSO1, PSO2</i>
<b>Unit 2: Shellfish culture</b>		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO2:</b> <ul style="list-style-type: none"> <li>To familiarize the learners about breeding, raising, and harvesting of shellfish</li> <li>To acquire the knowledge for management of crab culture, its present status, prospects, problems, and development in India</li> <li>To understand the breeding and rearing practices for brackish water prawns</li> <li>To understand the techniques used in the artificial production of pearls using pearl oysters and its commercial significance.</li> </ul>	<i>R, U, An, Ap</i>	<i>PO2, PO4, PO6, PO7, PO8</i>  <i>PSO1, PSO2</i>
<b>Unit 3: Fin Fish and other cultures</b>		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<b>CO3:</b> <ul style="list-style-type: none"> <li>To familiarize learners about hatchery and grow out practices for the culture of fresh water and brackish water fishes having commercial value</li> <li>To understand the techniques involved in the culture of seaweeds in order to meet its increasing demand in pharmaceutical and</li> </ul>	<i>R, U, An, Ap</i>	<i>PO2, PO4, PO6, PO7, PO8</i>

nutraceutical industries <ul style="list-style-type: none"> <li>To realize the potency of allied branches of aquaculture such as integrated aquaculture and sewage fed fishery.</li> </ul>		<i>PSO1, PSO2</i>
<b>Unit 4: Marketing and Finance</b>		
<b>Course Outcomes (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
<b>CO4:</b> <ul style="list-style-type: none"> <li>To inculcate an entrepreneurial culture by acquainting students to marketing and finance sector in aquaculture.</li> <li>To understand the professional ethics in global marketing and export-import procedures involved in aquaculture.</li> <li>To impart knowledge about finance, fund raising, schemes, subsidies and the role of corresponding authorities involved.</li> </ul>	<i>R, U, An, Ap</i>	<i>PO2, PO4, PO6, PO7, PO8</i>  <i>PSO1, PSO2</i>

<b>Course Code: SIPSZOOCN33</b> <b>Course Name: Fish Processing Technology</b> The study of this course will accomplish the following outcomes:		
<b>Unit 1: Logistics in fish processing</b>		
<b>Course Outcomes (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
<b>CO1:</b> <ul style="list-style-type: none"> <li>To familiarize learners about the vast array of opportunities offered by fish processing industry by acquainting them to various methods of fish processing.</li> <li>To impart knowledge about logistics, skill of handling and methods used in the transportation of fish in hygienic conditions at various levels before subjecting to processing.</li> <li>To study methods involved in assessing the freshness of fish.</li> <li>To analyze the relationships between physical parameters in fish transportation</li> </ul>	<i>R, U, An</i>	<i>PO2, PO4, PO6, PO7, PO8</i>  <i>PSO1, PSO2</i>
<b>Unit 2: Traditional fish processing</b>		
<b>Course Outcomes (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
<b>CO2:</b> <ul style="list-style-type: none"> <li>To get acquainted to different indigenous methods and materials implemented in fish processing.</li> <li>To realize the potential of traditional methods prevalent in fish processing and to understand their industrial modernization to meet the augmenting demand of consuming processed foods.</li> <li>To impart the knowledge and inculcate professional ethics about major equipment used in fish processing.</li> </ul>	<i>R, U, An, Ap, E</i>	<i>PO2, PO4, PO6, PO7, PO8</i>  <i>PSO1, PSO2</i>
<b>Unit 3: Modern fish processing</b>		
<b>Course Outcomes (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
<b>CO3:</b> <ul style="list-style-type: none"> <li>To cope up with current trends in fish processing by understanding modern fish processing techniques.</li> <li>To understand the processing of fish to make various fishery</li> </ul>	<i>R, U, An, Ap</i>	<i>PO2, PO4, PO6, PO7, PO8</i>

products by using advanced technology. <ul style="list-style-type: none"> <li>To realize the plethora of advanced techniques currently existing in fish processing industry which have unfolded new career prospects thereby inculcating an entrepreneurial approach.</li> </ul>		PSO1, PSO2
<b>Unit 4: Quality assurance norms and methods</b>		
<b>Course Outcomes (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
<b>CO4:</b> <ul style="list-style-type: none"> <li>To give in depth knowledge of recent methods in quality control and their norms and ethics.</li> <li>To understand various changes that occur during storage of fish and fish products and their corresponding protective measures.</li> <li>To understand and value the professional ethics involved in testing of various fish and fish products.</li> <li>To gain an understanding of various legislative measures in terms of National, International, Integrated food laws and corresponding regulating authorities.</li> </ul>	R, U, An	PO2, PO4, PO6, PO7, PO8  PSO1, PSO2

<b>Course Code: SIPSZOOCN34</b> <b>Course Name: Industry Internship/Training</b> The study of this course will accomplish the following outcomes:		
<b>NO THEORY PAPERS</b>		
<b>Course Outcomes (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
<b>Course outcomes:</b> <ul style="list-style-type: none"> <li>To give students structured training for exposure to real working environment.</li> <li>To work effectively and respectfully with diverse teams in diverse environments.</li> <li>To combine experiential learning with theoretical concepts.</li> <li>To increase employability of students.</li> <li>To strengthen academia-industry linkage.</li> <li>To acquire organizational skills and time management to set self-defined goals and targets with timelines.</li> </ul>	R, U, An, Ap	PO1, PO2, PO3, PO4, PO5, PO6  PSO2, PSO3, PSO4

### PRACTICAL

“Study nature not books.” – An old dictum.

The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

It is an effort to invigorate a thought process that can analyze and reason for the sake of awareness, hence to reach a valid answer.

<b><u>Oceanography and Fishery Science</u></b> <b><u>Semester III – Practical</u></b>
<b>Course Code: SIPSZOBTP31 and SIPSZOBTP32</b> <b>Course Name: Practical I &amp; II based on SIPSZOBT31 and SIPSZOBT32</b> The study of this course will accomplish the following outcomes:

Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<ul style="list-style-type: none"> <li>Comprehend the significance of aseptic techniques in biotechnological experiments and demonstrating those techniques-an important step to skill development in biotechnology.</li> <li>Understand the significance of culture media in microbiology, develop necessary skills for preparing culture media, demonstrate the techniques to culture bacteria using some commonly practiced techniques in laboratory.</li> <li>Isolation of genomic DNA from the given strain of bacteria/ tissue and show the purity of the isolate by performing agarose gel electrophoresis, thereby developing skills in electrophoretic techniques.</li> <li>Estimate the number of bacteria in the given culture by the technique of Nephelometry.</li> <li><i>Students Activity: Visit to the industries/institutes involved in Biotechnology research:</i> To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.</li> </ul>	R, U, An, Ap, E	PO2, PO5, PO6  PSO1, PSO2, PSO3
<b>Course Code: SIPSZOOCNP33</b> <b>Course Name: Practical III based on SIPSZOOCN33</b> The study of this course will accomplish the following outcomes:		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<ul style="list-style-type: none"> <li>To determine various physico-chemical parameters of sea water such as salinity, Dissolved O<sub>2</sub>, CO<sub>2</sub>, Nitrites-Nitrates, Silicates, Phosphates etc., in order to analyze their relationship with prevalence of marine organisms.</li> <li>To estimate the primary productivity of given sample water in order to understand the energy conversions in organisms.</li> <li>To identify and describe various intertidal organisms based on types of substrata they inhabit (rocky, sandy, muddy) in order to understand the differences in their morphological, anatomical, and behavioral adaptations.</li> <li>To gain an insight into the world of Micropaleontology which studies microfossils, its morphology, its characteristic details, and commercial importance.</li> <li><i>Student's activity:</i> Shore walks to observe and appreciate the parallel universe which emerges when the tide recedes. Also, to combine experiential learning in laboratory with actual observations on field.</li> <li><i>Visit to institutes involved in Marine Biology or Oceanography Research:</i> To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.</li> </ul>	R, U, An, Ap, E	PO1, PO2, PO6, PO7  PSO2, PSO3
<b>Course Code: SIPSZOOCNP34</b> <b>Course Name: Practical IV based on SIPSZOOCN34</b> The study of this course will accomplish the following outcomes:		
Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
<ul style="list-style-type: none"> <li>To appreciate the enormous world of microscopic splendors called plankton, various methods of quantitative estimation of zooplankton and develop a skill of preparing permanent mountings of zooplankton.</li> <li>To measure the reproductive capacity of a female fish, which in turn</li> </ul>	R, U, An, Ap, E	PO1, PO2, PO6, PO7  PSO2, PSO3

<p>elucidates the population dynamics, racial characteristics, production, and stock recruitment problems.</p> <ul style="list-style-type: none"> <li>• To measure the diameter and plotting the frequency polygon to interpret the growth and maturation in fish.</li> <li>• To identify and describe commercially important fishes with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.</li> <li>• <i>Student's activity:</i> Visit to fresh water hatchery/aquaculture farm to combine experiential learning in laboratory with actual observations on field.</li> <li>• <i>Visit to institutes involved in aquaculture research:</i> To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.</li> </ul>		
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**Course Code: SIPSZOOCNP31**

**Course Name: Practical I based on SIPSZOOCN31**

Course	Course outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOOCNP31	<p>1) <i>Identification of Oceanographic instruments:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe various oceanographic instruments used in analyzing different properties of sea water. Also, to identify and describe various devices practiced in the sampling of marine organisms.</li> </ul> <p>2) <i>Determination of physico-chemical parameters:</i></p> <ul style="list-style-type: none"> <li>• To determine various physico-chemical parameters of sea water such as salinity, Dissolved O<sub>2</sub>, CO<sub>2</sub>, Nitrites-Nitrates, Silicates, Phosphates etc., in order to analyze their relationship with prevalence of marine organisms.</li> </ul> <p>3) <i>Estimation of primary productivity by light and dark bottle</i></p> <ul style="list-style-type: none"> <li>• To estimate the primary productivity of given sample water in order to understand the energy conversions in organisms.</li> </ul> <p>4) <i>Identification of intertidal organisms:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe various intertidal organisms based on types of substrata they inhabit (rocky, sandy, muddy) in order to understand the differences in their morphological, anatomical, and behavioral adaptations.</li> </ul> <p>5) <i>Students Activity:</i></p> <ul style="list-style-type: none"> <li>• Shore walks to observe and appreciate the parallel universe which emerges when the tide recedes. Also, to combine experiential learning in laboratory with actual observations on field.</li> </ul> <p>6) <i>Visit to institutes involved in Marine Biology or Oceanography Research:</i></p> <ul style="list-style-type: none"> <li>• To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.</li> </ul>	R, U, An, Ap, E	PO1, PO2, PO6, PO7  PSO2, PSO3

**Course Code: SIPSZOOCNP32**

**Course Name: Practical II based on SIPSZOOCN32**

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOOCNP32	<ol style="list-style-type: none"> <li>1) <i>Identification of various farm equipment:</i> <ul style="list-style-type: none"> <li>• To identify and describe various farm equipment employed in an aquaculture farm in order to facilitate fish farming.</li> </ul> </li> <li>2) <i>Identification of various culture models:</i> <ul style="list-style-type: none"> <li>• To identify and describe various systems employed in aquaculture.</li> </ul> </li> <li>3) <i>Estimation of physico-chemical parameters of pond water:</i> <ul style="list-style-type: none"> <li>• To determine various physico-chemical parameters of pond water such as turbidity, Dissolved O<sub>2</sub>, CO<sub>2</sub>, pH, hardness etc., in order to analyze their relationship with the well-being of cultured species.</li> </ul> </li> <li>4) <i>Identification of Aquaculture feed:</i> <ul style="list-style-type: none"> <li>• To identify and describe various feed (natural and formulated) used in aquaculture practices and to understand the importance of dosage in feeding.</li> </ul> </li> <li>5) <i>Study of developmental stages in fish:</i> <ul style="list-style-type: none"> <li>• To study developmental stages in fish life cycle in order to strengthen the concepts of fish farming.</li> </ul> </li> <li>6) <i>Study of various components of fish hatchery:</i> <ul style="list-style-type: none"> <li>• To get an insight into the various components of a fish hatchery unit.</li> </ul> </li> <li>7) <i>Students Activity:</i> <ul style="list-style-type: none"> <li>• Visit to fresh water hatchery/aquaculture farm to combine experiential learning in laboratory with actual observations on field.</li> </ul> </li> </ol>	R, U, An, Ap, E	PO1, PO2, PO3, PO6, PO7  PSO2, PSO3

**Course Code:** SIPSZOOCNP33

**Course Name:** Practical III Based on SIPSZOOCN33

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
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SIPSZOOCNP33	<p>1) <i>Organoleptic tests to evaluate the freshness of the given fish specimen:</i></p> <ul style="list-style-type: none"> <li>• To maximize the value of the fishes, freshness quality must be maintained which has become a global concern in fishing industry.</li> <li>• To increase the acceptability of the fish product, the method of quality assessment must be known.</li> <li>• To avoid the ingestion of contaminated food; to evaluate the nutritive value of food by detecting the presence of biological, chemical, and physical hazards and in the end to ensure the safety of the consumer.</li> </ul> <p>2) <i>Dressing and Grading of Shrimps and dressing and filleting of given fish species:</i></p> <ul style="list-style-type: none"> <li>• To acquire a skill of dressing and grading of given shrimp/prawn species.</li> <li>• To develop a holistic approach to work at an industrial level wherein whole raw shrimp on receipt are first graded for size and then dressed. Also, to inculcate a culinary approach which accounts for the interdisciplinary of the course.</li> </ul> <p>3) <i>Preparation of Prawn pickle, Fish Burger, Surimi:</i></p> <ul style="list-style-type: none"> <li>• To prepare value added products for human consumption in order to increase the utilization of underutilized low value fishes which are rich in nutrients.</li> </ul> <p>4) <i>Identification of various equipment used in fish processing:</i></p> <ul style="list-style-type: none"> <li>• To promote a practical, professional, and procedural knowledge required for carrying out professional or highly skilled tasks related to advanced thermal and non-thermal technologies in fish processing.</li> </ul>	R, U, An, Ap, E	<p>PO1, PO2, PO4, PO6, PO7</p> <p>PSO2, PSO3</p>
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**Course Code:** SIPSZOOCNP34

**Course Name:** Practical IV based on SIPSZOOCN34

Course	Course Outcome(CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOOCN34	<ul style="list-style-type: none"> <li>• Students are required to present the work done during the course of internship in order to:</li> <li>• Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.</li> <li>• Confidently share views and express themselves.</li> <li>• Use ICT in a variety of learning and work situations</li> <li>• Access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.</li> </ul>	R, U, An, Ap, E, C	<p>PO1, PO2, PO3, PO4, PO6</p> <p>PSO1, PSO2, PSO3</p>

## Oceanography and Fishery Science

### Semester IV – Theory

**Course Code:** SIPSZOOCN41

**Course Name:** Fishery Science

The study of this course will accomplish the following outcomes:

<b>Unit</b>	<b>Course Outcome (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
Unit 1: Marine finfish resources in Pelagic and Demersal systems	<b>CO1:</b> <ul style="list-style-type: none"><li>To gain knowledge of Fishery Science that opens an avenue for bioeconomics.</li><li>To gain in depth knowledge of marine finfish resources in pelagic and demersal systems.</li><li>To understand the fluctuations in Oil sardine fishery in India and to get acquainted to the utilization of oil sardine.</li><li>To study commercially important fish species, their distribution, crafts, and gears operated, utilization and recent data on their landing.</li></ul>	<i>R, U, An</i>	<i>PO2, PO6, PO7</i>  <i>PSO1, PSO2</i>
Unit 2: Marine Shellfish resources in Pelagic and Demersal systems	<b>CO2:</b> <ul style="list-style-type: none"><li>To gain knowledge of Fishery Science that opens an avenue for bioeconomics.</li><li>To gain in depth knowledge of marine shellfish resources in pelagic and demersal systems.</li><li>To get an insight into crustacean fisheries, commercially important species, distribution, methods of capture, recent data on their catch.</li><li>To get an insight into crustacean fisheries, commercially important species, distribution, methods of capture, recent data on their catch.</li></ul>	<i>R, U, An</i>	<i>PO2, PO6, PO7</i>  <i>PSO1, PSO2</i>
Unit 3: Trophodynamics in aquatic systems	<b>CO3:</b> <ul style="list-style-type: none"><li>To learn the dynamics of nutrition and the flow of energy in aquatic food webs.</li><li>To study various indices involved in the food and feeding analysis.</li><li>To understand the use of trophodynamics as a tool for the study of aquatic ecosystem.</li><li>To understand the effect of fishing on prey-predator relationship in marine environment in order to obtain maximum sustainable yield.</li></ul>	<i>R, U, An, E</i>	<i>PO1, PO2, PO6, PO7</i>  <i>PSO1, PSO2</i>
Unit 4: Marine fishery-Economics and Conservation	<b>CO4:</b> <ul style="list-style-type: none"><li>To know about the current trends in global as well as national capture fishery.</li><li>Concept of management and conservation of wild stock, conservation of genetic and ecological diversity</li><li>To get acquainted to the significance of Fishermen communities in fishery, agencies which focus on development of fish farmers and Fishery Extension Programs.</li></ul>	<i>R, U, An, E</i>	<i>PO2, PO6, PO7</i>  <i>PSO1, PSO2</i>

**Course Code:** SIPSZOOCN42

**Course Name:** Marine Biotechnology, Toxicology and Fish pathology

The study of this course will accomplish the following outcomes:



Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Marine Biotechnology	<b>CO1:</b> <ul style="list-style-type: none"> <li>To understand the history of biotechnology and to gain knowledge of applications of biotechnology in various fields of marine biology to improve human values.</li> <li>To learn advanced techniques used in cryopreservation of fish gametes and understand the steps involved in developing the transgenic fish.</li> <li>To study the gene transfer in common carp and channel fish.</li> </ul>	<i>R, U, An, Ap</i>	<i>PO1, PO2, PO4, PO7</i>  <i>PSO1, PSO2</i>
Unit 2: Marine toxicology	<b>CO2:</b> <ul style="list-style-type: none"> <li>To establish the relationship of toxicology with other sciences by studying history and scope of toxicology and understanding the dose response relationships, sources, and movements of toxicants.</li> <li>To understand the primary classification of toxicants, terminologies used and types of toxicants</li> <li>To learn about the factors determining the degree of toxicity and common effects.</li> <li>To impart basic conceptual understandings of heavy metal toxicity, toxicity caused by agrochemicals in fishes and their effects.</li> </ul>	<i>R, U, An, E</i>	<i>PO1, PO2, PO4, PO7</i>  <i>PSO1, PSO2</i>
Unit 3: Marine Bioactive Compounds	<b>CO3:</b> <ul style="list-style-type: none"> <li>To gain knowledge about natural marine substances present in algae, fungi and bacteria and their bioactivities.</li> <li>To study various bioactive metabolites from marine animals</li> <li>To understand the toxic effects of marine bioactive compounds, types of screening and testing methods involved in clinical evaluation.</li> </ul>	<i>R, U, An, Ap</i>	<i>PO1, PO2, PO4, PO7</i>  <i>PSO1, PSO2</i>
Unit 4: Fish pathology	<b>CO4:</b> <ul style="list-style-type: none"> <li>To get familiarized with fish pathology with respect to pollutants and adverse biological factors in the aquatic environment.</li> <li>To study fish parasitology by understanding types of parasites, the sites of infection in various fish species.</li> <li>To learn the various pathogenic bacteria, their habitat, epizootiology and treatment.</li> <li>To get conceptual understanding of the mycology of fish by studying various types of oomycetes.</li> </ul>	<i>R, U, An, Ap</i>	<i>PO1, PO2, PO4, PO7</i>  <i>PSO1, PSO2</i>

**Course Code:** SIPSZOOCN43

**Course Name:** Marine Biodiversity Conservation, EIA and CRZ

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
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<p>Unit 1: Marine Biodiversity- Mangroves, Corals, Marine Birds, marine Mammals, marine reptiles, and their Conservation</p>	<p><b>CO1:</b></p> <ul style="list-style-type: none"> <li>• To make students mindful of the marine biodiversity and its conservation</li> <li>• To inculcate the awareness about rich faunal diversity, its distribution, adaptations, and conservative measures in marine ecosystems.</li> <li>• To get acquainted to the conservation and management of significant marine habitats.</li> </ul>	<p><i>R, U, An</i></p>	<p><i>PO2, PO5, PO6, PO7</i></p> <p><i>PSO1, PSO2, PSO3</i></p>
<p>Unit 2: Marine Biodiversity Conservation laws and marine protected areas of India</p>	<p><b>CO2:</b></p> <ul style="list-style-type: none"> <li>• To get the information about the legislative measures and the norms designed by the government to encourage biodiversity conservation.</li> <li>• To ensure the conservation of biological diversity, sustainable use of its components and fair usage of its resources in order to prevent overuse or eventual destruction of biodiversity.</li> <li>• To safeguard and foster the cardinal marine habitats and representative marine life by designing Marine Protected Areas (MPAs) thereby restoring the productivity of the oceans and avoid further degradation.</li> <li>• To get acquainted to various legislative measure taken towards conservation of marine resources on National and International level.</li> <li>• To gain an insight into international approaches to conservation and sustainable development, ongoing Problems, possible responses, role of conservation biologists.</li> </ul>	<p><i>R, U, An, Ap</i></p>	<p><i>PO2, PO5, PO6, PO7</i></p> <p><i>PSO1, PSO2</i></p>
<p>Unit 3: Environmental impact assessment and Coastal regulatory Zone</p>	<p><b>CO3:</b></p> <ul style="list-style-type: none"> <li>• <i>EIA (Environment Impact Assessment):</i></li> <li>• To analyze, evaluate, predict, and mitigate the potential environmental effects that could occur from the anthropogenic activities before they are put into action.</li> <li>• To develop a tool for promoting sustainable development, ensuring the protection of the environment, analyzing potential environmental impacts, integrating environmental considerations into project planning, and enabling public participation.</li> <li>• <i>CRZ (Coastal Regulatory Zone):</i></li> <li>• To ensure the protection of ecologically sensitive Areas like mangroves, coral reefs which act as a shield against tsunami and cyclone.</li> <li>• To perk up the lives of coastal communities like fishing communities</li> <li>• To have resilient measures for mitigating impacts of climate change and high-intensity cyclones.</li> <li>• To balance development with conservation of the coastal environment.</li> </ul>	<p><i>R, U, An, Ap</i></p>	<p><i>PO2, PO5, PO6, PO7</i></p> <p><i>PSO1, PSO2</i></p>

Unit 4: Ocean policies and Management	<b>CO4:</b> <ul style="list-style-type: none"> <li>To understand historical evolution of open ocean as a common heritage of mankind.</li> <li>To gain in depth knowledge about the Ocean Policies and their management.</li> <li>To make students mindful of the laws of the sea, its significance, regulating authorities.</li> <li>To gain an insight into the national and international regulations for sea-bed exploration.</li> <li>To learn about the role of national and international agencies and organizations in ocean management. Also, to understand the Intellectual Property Right (IPR) with reference to Ocean policy (India).</li> </ul>	<i>R, U, An, Ap</i>	<i>PO2, PO5, PO6, PO7</i>  <i>PSO1, PSO2</i>
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**Course Code:** SIPSZOOCN44

**Course Name:** Research Project/Dissertation

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
No theory papers	<b>CO1:</b> <ul style="list-style-type: none"> <li>To inculcate research aptitude and develop an open, inquiring mind amongst the students.</li> <li>To encourage students to explore new territories and learn new things.</li> <li>To encourage the spirit of curiosity of students and to think of research as potential career option.</li> <li>To motivate and inspire students to come up with solutions for real life problems facing the society and nation.</li> </ul>	<i>R, U, An, Ap, E, C</i>	<i>PO1, PO2, PO3, PO4, PO5, PO6</i>  <i>PSO1, PSO2, PSO3, PSO4</i>

### Oceanography and Fishery Science

#### Semester IV – Practical

**Course Code:** SIPSZOOCNP41

**Course Name:** Practical I based on SIPSZOOCN41

Course	Course Outcome(CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOOCNP41	<ol style="list-style-type: none"> <li><i>Study of food and feeding habits in fish:</i> <ul style="list-style-type: none"> <li>To elucidate the factors which influence distribution, migration, and growth of fish by studying their feeding habits. It provides a key to understand many aspects of fish biology, physiology, and behavior and their conservation.</li> </ul> </li> <li><i>Identification of crafts and gears:</i> <ul style="list-style-type: none"> <li>To identify and describe various crafts and gears operated along the coast of India.</li> </ul> </li> <li><i>Biometric studies of fish/prawn:</i> <ul style="list-style-type: none"> <li>To provide crucial information on fish population growth and aquatic habitat well-being.</li> </ul> </li> </ol>	<i>U, An, Ap, E</i>	<i>PO2, PO6, PO7</i>  <i>PSO1, PSO2, PSO3</i>

	<p>4) <i>Fecundity and maturation studies on fish and plotting frequency polygon by ova diameter measurement:</i></p> <ul style="list-style-type: none"> <li>• To measure the reproductive capacity of a female fish, which in turn elucidates the population dynamics, racial characteristics, production, and stock recruitment problems.</li> <li>• To measure the diameter and plotting the frequency polygon to interpret the growth and maturation in fish.</li> </ul> <p>5) <i>Identification of commercially important crustaceans:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe commercially important crustaceans with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.</li> </ul> <p>6) <i>Identification of commercially important molluscs:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe commercially important molluscs with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.</li> </ul> <p>7) <i>Identification and classification of marine fish:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe commercially important fishes with respect to capture fishery, their distribution, commercial value, crafts, and gears operated.</li> </ul> <p>8) <i>Student's activity:</i></p> <ul style="list-style-type: none"> <li>• Visit to local Fish landing centers, Local fish markets, Fishermen villages in and around Mumbai.</li> </ul>		
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**Course Code: SIPSZOO CNP42**

**Course Name: Practical II based on SIPSZOO CN42**

Course	Course Outcome(s)(CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOO CNP42	<p>1) <i>Detection of Heavy metals:</i></p> <ul style="list-style-type: none"> <li>• To detect the presence of heavy metals in given sea water sample, understand and analyze their effects on marine life.</li> </ul> <p>2) <i>Identification of Gene transfer technology in fish:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe various gene transfer technologies practiced in marine biotechnology, equipment used, advantages and disadvantages.</li> </ul> <p>3) <i>Identification of fish pathogens and fish microflora using basic microbial techniques:</i></p> <ul style="list-style-type: none"> <li>• To identify and describe various fish pathogens, their clinical pathology and treatment. Also, to identify common fish microflora using basic microbial techniques.</li> </ul> <p>4) <i>Qualitative tests for assessing bioactive compounds:</i></p> <ul style="list-style-type: none"> <li>• To assess various bioactive metabolites obtained from some common marine organisms</li> </ul>	U, An, Ap, E	<p>PO2, PO6, PO7</p> <p>PSO1, PSO2, PSO3</p>

	by performing qualitative tests.		
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**Course Code: SIPSZOOCNP43**

**Course Name: Practical III based on SIPSZOOCN43**

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOOCNP43	<p>1) <i>Identification of Foraminiferan shells:</i></p> <ul style="list-style-type: none"> <li>To gain an insight into the world of Micropaleontology which studies microfossils, its morphology, its characteristic details, and commercial importance.</li> </ul> <p>2) <i>Identification of marine animals:</i></p> <ul style="list-style-type: none"> <li>To appreciate diverse marine fauna (Marine birds, reptiles, and mammals), their distribution, adaptations migration and conservation.</li> </ul> <p>3) <i>Case studies based on EIA and CRZ notifications:</i></p> <ul style="list-style-type: none"> <li>To practically apply the knowledge and understanding of the facts regarding EIA and CRZ to a real-world situation.</li> </ul> <p>4) <i>Identification of common mangrove species and associates:</i></p> <ul style="list-style-type: none"> <li>To cherish these unsung heroes of aquatic ecosystems. To understand their diversity, distribution, adaptations, and conservation.</li> </ul> <p>5) <i>Identification of common corals species:</i></p> <ul style="list-style-type: none"> <li>To gain an insight into these esteemed wonders of marine ecosystems, their diversity, distribution, adaptations, and conservation.</li> </ul> <p>6) <i>Identification and preparing permanent mountings of zooplankton:</i></p> <ul style="list-style-type: none"> <li>To appreciate the enormous world of these microscopic splendors and develop a skill of preparing permanent mountings of organisms.</li> </ul> <p>7) <i>Student's activity: Visit to coastal and mangrove areas:</i></p> <ul style="list-style-type: none"> <li>To observe and appreciate the marine marvels and protectors of estuaries in their natural habitat.</li> <li>To combine experiential learning in laboratory with actual observations on field.</li> </ul> <p>8) <i>Student's activity: Shell collection, Algae collection, and preparation of Herbaria:</i></p> <ul style="list-style-type: none"> <li>To carry out an elaborate study involving identification, characterization, and preservation of molluscs and algae.</li> </ul> <p><i>(Note: Only abandoned molluscan shells and washed ashore algae specimen are collected and collection is as minimal as possible)</i></p>	U, An, Ap, C	<p>PO2, PO6, PO7</p> <p>PSO1, PSO2, PSO3</p>

**Course Code: SIPSZOOCNP44**

**Course Name: Practical IV based on SIPSZOOCN44**

Course	Course Outcome(CO)	Cognitive Level	Affinity with PO/ PSO
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SIPSZOOCNP44	<p><b>Course Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Students are required to present the work done during the course of research project in the form of Dissertation and PowerPoint presentation in order to:</li> <li>• Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.</li> <li>• Confidently share views and express themselves.</li> <li>• Use ICT in a variety of learning and work situations</li> <li>• Access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.</li> </ul>	<i>R, U, An, Ap, E, C</i>	<i>PO1, PO2, PO3, PO4, PO5, PO6</i>  <i>PSO1, PSO2, PSO3, PSO4</i>
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**Semester III – Theory**  
**Paper Code: SIPSZOOCN31**  
**Paper I: General, Physical, Chemical and Biological Oceanography**

**Learning Objectives**

- To introduce students to the different aspects of Oceanography and to learn about the general features of the earth's surface under water with reference to the ocean waters of the Indian subcontinent.
- To acquaint students to ship-building, tools used for oceanographic studies and research.
- To analyze the physical attributes of sea water and comprehend their influence on aquatic life; to throw light on ocean circulation – a key regulator of climatic changes.
- To familiarize students with physical aspects of Oceanography such as tides, waves and currents that not only influence aquatic life but also life on the terrestrial realm.
- To make students appreciate the value of the mineral resources that are obtained from the oceans and their large-scale applications.
- To appreciate the vast array of life forms found in the ocean from bacteria to large nektons and their adaptations and associations to best suit the niche in which they thrive, and to study the influence of the physical factors prevalent in the oceans.

**Unit 1: General Oceanography:**

**15 Lectures**

- 1.1 Geological time scale and major Physico-chemical and biological events in Earth's History
- 1.2 Ocean floor morphology
- 1.3 Oceanographic History, Oceanographic Expeditions: Challenger, Indian Ocean and Antarctic
- 1.4 Introduction to shipbuilding:
  - 1.4.1 Purchase and Basic Design of the Ship
  - 1.4.2 Materials and Strength of ships
  - 1.4.3 Ship Structure
  - 1.4.4 Typical oceanographic research Vessel, its equipment
- 1.5 Ocean bottom topography:
  - 1.5.1 Continental shelf
  - 1.5.2 Continental slope
  - 1.5.3 Submarine canyons
  - 1.5.4 Submarine Mountain ranges
  - 1.5.5 Sea mounds and Guyots
  - 1.5.6 Oceanic ridges and rises
  - 1.5.7 Oceanic trenches
  - 1.5.8 Abyssal floor

**Unit 2: Physical Oceanography:**

**15 Lectures**

- 2.1 Sea Water:
  - 2.1.1 Physical properties of sea water- Salinity-Temperature-Density relationship
  - 2.1.2 Sound in the sea, Light in the sea
- 2.2 Oceanographic circulation:
  - 2.2.1 Wind induced circulation, thermohaline circulation and upwelling of water
  - 2.2.2 Ekman spiral, Geostrophic current, Westward intensification with dynamic Topography
  - 2.2.3 Coriolis Effect and EL Nino Effect
- 2.3 Waves- Characteristics of waves, deep water, and shallow water waves, transitional Waves, wind generated waves, internal waves, and Tsunami
- 2.4 Tides- Tide generating forces, their causes, variation and types, Tidal currents Importance of tide tables - tide and wave energy

**Unit 3: Chemical Oceanography:****15 Lectures**

- 3.1 Composition of sea water: Constancy of its composition and factors affecting the composition, major and minor constituents, trace elements and their biological role
- 3.2 Dissolved gases in sea water and their role in the environment; carbon dioxidesystem, dissolved oxygen and oxygen profile, hydrogen Sulphide
- 3.3 Nutrients in the ocean, their cycles and factors influencing their distribution: Nitrogen, Phosphorus, Silicon
- 3.4 Mineral resources from the sea:
  - 3.4.1 : Deep Sea mud oozes and Manganese nodules
  - 3.4.2 Oil, Gas and Sulphur deposits
  - 3.4.3 Resources along the continental margin

**Unit 4: Biological Oceanography:****15 Lectures**

- 4.1 Division of Marine environment
- 4.2 Intertidal organisms and their zonation
- 4.3 Marine biotic diversity-
  - 4.3.1: Plankton
  - 4.3.2: Nekton
  - 4.3.3: Benthos
  - 4.3.4: Indices of species richness, measuring diversity, models explaining diversitygradient
- 4.4 Effect of physical factors on marine life:
  - 4.4.1 : Light: Photosynthesis, coloration, structural adaptations, and bioluminescence
  - 4.4.2 Temperature: Tolerance, geographical distribution, size, calcium precipitation, metabolism, bipolarity, tropical submergence, and periodicity
  - 4.4.3: Salinity: Tolerance and distribution, size, buoyancy, and osmoregulation
  - 4.4.4: Currents: Role in nutrition, transportation, and propagation
- 4.5 Animal association in marine environment: Endemism, Inquilinism, Phoresis, Epizoism, Mutualism, symbiosis, parasitism

*Student's activity:* Shore walks to observe and appreciate the parallel universe which emerges when the tide recedes. Also, to combine experiential learning in laboratory with actual observations on field.

*Visit to institutes involved in Marine Biology or Oceanography Research:* To gain knowledge about potential areas in oceanographic research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.



**Semester III – Theory**  
**Paper Code: SIPSZOOCN32**  
**Paper II: Aquaculture**

***Learning Objectives***

- To introduce aquaculture to know its immense potential for generating employment; to acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit. Also, to consider aquaculture as a subsidiary in the income of someone having a taste for it.
- To attain a clear perception of the present status of sea farming in India.
- To impart essential knowledge and skills regarding advanced technologies of different aquaculture production systems.
- To familiarize the learners about breeding, raising, and harvesting of shellfish, finfish, and aquatic plants.
- To inculcate an entrepreneurial culture by acquainting students to marketing and finance sector in aquaculture

**Unit 1: Aquaculture- an Introduction**

**15 Lectures**

- 1.1: History, scope, and importance of aquaculture
- 1.2: Aquaculture practices in India
- 1.3: Cultivable organisms for aquaculture and criterion for their selection
- 1.4: Different systems of aquaculture such as Pond Culture, Cage Culture, Pen Culture, Running Water Aquaculture, Raft Culture, Aqua ranching
- 1.5: Impact of aquaculture on environment
- 1.6: Present status of Sea farming in India
- 1.7: World and Indian aquaculture production and trends

**Unit 2: Shell Fish culture**

**15 Lectures**

- 2.1 Crab culture
  - 2.1.1 Introduction, History and Present status of crab culture
  - 2.1.2 Cultivable species of crabs in India
  - 2.1.3 Pond design
  - 2.1.4 Principles of crab hatchery, brood stock, larval and post-larval management
  - 2.1.5 Techniques of Crabs culture
  - 2.1.6 Prospect, problems, and development of crab culture in India
- 2.2 Brackish water Prawn – *Penaeus monodon* Culture
  - 2.2.1 Breeding techniques
  - 2.2.2 Hatchery & Nursery Management
  - 2.2.3 Rearing practices
- 2.3 Pearl oyster culture
  - 2.3.1 Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls
  - 2.3.2 Pearl culture techniques

**Unit 3: Fin Fish and other cultures**

**15 Lectures**

- 3.1 Hatchery and grow out practices for the culture of Fresh water fishes- Indian Major Carps (Rohu, Catla, Mrigal, Pangasiodon)
- 3.2 Hatchery and grow out practices for the culture of brackish water fishes:
  - 3.1.1 *Chanos chanos* (Breeding techniques Hatchery & Nursery Management, Rearing practices)
  - 3.1.2 *Lates calcarifer* (Breeding techniques Hatchery & Nursery Management, Rearing practices)
- 3.4 Seaweed culture
- 3.5 Integrated aquaculture and Sewage-fed fishery

**Unit 4: Marketing and Finance**

**15 Lectures**

- 4.1 Traditional marketing vis-a-vis role of fishery co-operatives with reference to operations at Satpati, Sasoon dock and Karanja
- 4.2 Global marketing and Export-Import procedures and role of Marine Products Exports Development Authority (MPEDA)
- 4.3 Finance:
  - 4.3.1 Fund raising: Financial institutions, Schemes and subsidies, Basic accounting, Costing and feasibility report
  - 4.3.2 Role of NABARD (National Bank for Agriculture and Rural Development) for refinancing and NFDB (National Fishery Development Board, Hyderabad) for funding through the State Government

*Student's activity: Visit to fresh water hatchery/aquaculture farm to combine experiential learning in laboratory with actual observations on field.*

*Visit to institutes involved in aquaculture research: To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.*

**Semester III – Theory**  
**Paper Code: SIPSZOOCN33**  
**Paper III: Fish processing technology**

***Learning Objectives***

- *To impart knowledge of the vast array of opportunities offered by Fish processing industry by acquainting them to various methods of fish processing.*
- *To familiarize the learners about logistics and skill of handling of fish in hygienic conditions at various levels. Also, to assess freshness of fish.*
- *To get acquainted with different methods and materials required in traditional and recent methods in fish processing.*
- *To give in depth knowledge of recent methods in quality control and their norms.*

**Unit 1: Logistics in fish processing**

**15 Lectures**

- 1.1 Methods of handling of fish
- 1.2 Hygienic conditions required on board, landing centers and processing industry
- 1.3 Methods of transportation (conventional and recent) of fish to processing industry
- 1.4 Organoleptic tests
- 1.5 Temperature modeling and relationships in fish transportation

**Unit 2: Traditional fish processing**

**15 Lectures**

- 2.1 Indigenous methods of preservation (Drying, Salting, Smoking)
- 2.2 Simple Vapor Compression System (Refrigerator):
  - 2.2.1 Ideal refrigerant
  - 2.2.2 Types of refrigerants
- 2.3 Types of freezers, freezing of fin fishes and shell fishes
- 2.4 Canning of fin fishes
- 2.5 Additives in fish processing
- 2.6 Major equipment used in fish processing industry

**Unit 3: Modern fish processing**

**15 Lectures**

- 3.1 Surimi technology and Surimi based analogue products (only technology aspect)
- 3.2 Thermal processing of fishery products
  - 1.2.1 Thermal processing
  - 1.2.2 Pulsed light technology
  - 1.2.3 Infra-red (IR) and Radio frequency (RF) processing technology and its applications

- 1.2.4 Ohmic or Joule heating
- 3.3 Non-thermal processing of fishery products
  - 1.3.1 High pressure processing
  - 1.3.2 Vacuum cooling
  - 1.3.3 Irradiation

**Unit 4: Quality assurance norms and methods**

**15 Lectures**

- 4.1 Introduction to Quality Assurance
- 4.2 Microbiological testing: Standard norms, Biogenic amines, Rapid detection kits
- 4.3 Hazard Analysis Critical Control Point (HACCP)
- 4.4 Check list for ensuing sea food safety
- 4.5 Changes that occur during freezing and frozen storage (Microbiological, Physical and Chemical changes, Protein denaturation, Fat oxidation, Dehydration, Drip), Protective Treatments: (Polyphosphate, Glazing, Antioxidants, Packaging)
- 4.6 National and International food laws, integrated food law (FSSAI, CODEX GMP)

*Student's activity: Visit to fish processing industry to combine experiential learning in laboratory with actual observations on field.*

*Visit to institutes involved in fish processing: To gain knowledge about potential areas in research, research trends, methodology, instrumentation, facilities in order to inculcate a research-based attitude.*

**Semester III- Theory**  
**Paper Code: SIPSZOOCN34**  
**Paper IV: Industry Internship/Training**

***Learning objectives***

- *to give students structured training for exposure to real working environment*
- *to combine experiential learning with theoretical concepts*
- *to increase employability of students*
- *to strengthen academia-industry linkage*

**M.Sc. Part II – Zoology (Oceanography and Fishery Science)**  
**Practical's in Semester III**

**Practical - I (SIPSZOOCNP31)**  
**Based on SIPSZOOCN31**

- 1) Identification of Oceanographic instruments
  - a) Nansen reversing bottle
  - b) Deep sea reversing thermometer
  - c) Bathythermometer
  - d) Drift bottle
  - e) Ekman's current meter
  - f) Secchi's disc
  - g) Plankton nets: Standard net, Hensen's net and Clarke Bumpus net
  - h) Stempel pipette and counting slide
  - i) Nekton sampling device: Trawls
  - j) Benthic sampling devices: Dredges, grabs, and corers
- 2) Determination of physico-chemical parameters:
  - a) Salinity
  - b) Dissolved oxygen
  - c) Carbon dioxide
  - d) Nitrates-nitrites
  - e) Silicates
  - f) Phosphate-phosphorus
- 3) Estimation of primary productivity by light and dark bottle

- 4) Identification of intertidal organisms:
  - a) Rocky shore: *Patella*, *Chiton*, *Fissurella*, *Mytilus*, *Perna viridis*, *Cardium*, *Balanus*, *Gorgonids*, *Littorina* and corals
  - b) Sandy shore: *Solen*, *Umbonium*, *Oliva*, Pea crab, Fiddler crab, Molluscan shells, Star fish and *Balanoglossus*
  - c) Muddy shore: *Lingula*, *Chaetopterus*, *Arenicola*, Tubiculus worm and Mud skipper
- 5) Students Activity: Observation of intertidal flora and fauna during field visit and submit a report.
- 6) Visit to Institutes involved in Marine Biology or Oceanography Research.

#### **Practical-II (SIPSZOOCNP32)**

##### **Based on SIPSZOOCN32**

- 1) Identification of various farm equipment:  
Feeding cups, trays, paddle wheels, aerators, fountains, Sluice gate models, elbow pipe outlets
- 2) Identification of various culture models (Pen, Cage, Rope, Raft systems)
- 3) Estimation of Turbidity, DO, pH, Hardness CO<sub>2</sub> and BOD of pond water
- 4) Identification of Aquaculture feed:  
Green algae, blue-green algae, *spirulina*, diatoms, *infusoria*, rotifers, Cladocera, Tubifex, Brine shrimp, Chironomids.
- 5) Study of developmental stages in fish – Eggs, hatchings, and fingerlings
- 6) Study of various components of fish hatchery
- 7) Identification of Formulated fish feed
- 8) Student's activity: Visit to fresh water hatchery/aquaculture farm and submit a report.

#### **Practical-III (SIPSZOOCNP33)**

##### **Based on SIPSZOOCN33**

- 1) Organoleptic tests of freshness of fish and fishery products.
- 2) Dressing (Beheading, Peeling and Deveining) and grading of shrimps
- 3) Fish dressing and filleting
- 4) Preparation of prawn pickle
- 5) Preparation of fish burger
- 6) Preparation of Surimi
- 7) Identification of various equipment used in fish processing:
  - a) Thermal processing
  - b) Pulsed light technology
  - c) Infra-red (IR) and Radio frequency (RF) processing
  - d) Ohmic or Joule heating
  - e) High pressure processing
  - f) Vacuum cooling
  - g) Irradiation
- 8) Student's activity: Visit to fish processing industry, fish landing centers, cold storages and ice plants

#### **Practical - IV (SIPSZOOCNP34)**

##### **Based on SIPSZOOCN34**

**Background:** As a part of the M.Sc Degree program in the subject of Zoology, the M.Sc. Part 2 students are required to complete an Internship / Training program at Industry / Company / Research Institute / Organization for gaining industrial experience related to the subject and or the area of specialization. This exercise carries a total of 150 marks which is partly based on the evaluation of the performance of the student by the competent authority at the industry where the student is placed and an evaluation by a team of examiners at the college during their semester end examination.

#### **Modalities of Evaluation:**

##### **1. Industry Diary / Rough Journal :**

Each student will maintain an Industry Diary / Rough Journal for keeping a record of daily activities carried out during the working period at the industry. The diary entries are to be evaluated and approved by a competent authority at the department / section where the student is placed. The diary entries must **NOT** contain any confidential information or any information that may infringe the intellectual property rights of the industry. The diary entries should be general with no details of specifics.

##### **2. Continuous Evaluation :**

The student needs to be continually evaluated for his / her performance at the industry. This evaluation may be based on a suitable criteria and modality as found appropriate and feasible at the industry. The evaluation may be

best made by the immediate superior or the departmental / sectional head to whom the student reports. The evaluator may also keep regular record of the evaluations made.

### **3. End of Program Evaluation;**

At the end of period, the immediate superior or the departmental / sectional head to whom the student reports, should make an evaluation report in the format attached with this document. The evaluation document will be approved by a competent authority at the senior managerial level, directly in the same vertical, where the student is placed.

**Semester IV – Theory**  
**Paper Code: SIPSZOO CN41**  
**Paper I: Fishery Science**

#### ***Learning objectives***

- *To gain knowledge of Fishery Science that opens an avenue for bioeconomics.*
- *To gain in depth knowledge of marine finfish and shellfish resources in pelagic and demersal systems.*
- *To offer an insight in the field of trophodynamics in aquatic ecosystems.*
- *To impart the knowledge of Economics and Conservation in order to develop a sustainable approach.*
- *To know about the current trends in global as well as national capture fishery.*
- *To get acquainted to the significance of Fishermen communities in fishery, agencies which focus on development of fish farmers and Fishery Extension Programs.*

**Unit 1: Marine finfish resources in Pelagic and Demersal systems** **15 Lectures**

- 1.1 Oil Sardine fishery
  - 1.1.1 Fluctuations in landings of oil sardine fishery from year to year
  - 1.1.2 Utilization of the catch.
- 1.2 Mackerel Fishery
- 1.3 Bombay-duck fishery
- 1.4 Sole Fishery and Ribbon fish fishery
- 1.5 Shark and Ray fishery

**Unit 2: Marine shellfish resources in Pelagic and Demersal systems** **15 Lectures**

- 2.1 Crustacean fisheries
  - 2.1.1 Prawn and Shrimp Capture Fishery
  - 2.1.2 Crab Capture Fisheries
- 2.2 Molluscan Fisheries
  - 2.2.1 Commercial and edible species of Oysters, Mussels, Clams, Gastropods, Cephalopods.
  - 2.2.2 Lime yielding Molluscan shells

**Unit 3: Trophodynamics in Aquatic systems** **15 Lectures**

- 3.1 Concept of Trophodynamics
- 3.2 Methods of food and feeding analysis, gut content analysis, Index of relative importance (IRI), Gastro Somatic index (GSI), Forage ratio.
- 3.3 Food digestion and energetics
- 3.4 Fishing effect on prey and predator species and their interaction.
- 3.5 Morphological and anatomical feeding adaptations in fishes.
- 3.6 Self-regulation of fish stock density in the event of change in food supply.

**Unit 4: Marine Fishery- Economics and Conservation** **15 Lectures**

- 4.1 Major fishing nations of the world. Present trend of marine capture fisheries. Statistics on world fish catches.
- 4.2 Growth in marine fisheries and current status of India in marine fish production and export.
- 4.3 Concept of management and conservation of wild stock, conservation of genetic and ecological diversity, IUCN red list categories, measures for fish conservation.
  - 4.3.1 Fisheries economics and extension, Russel's equation, production and yield, overfishing, ranching, Satellite/ Aircraft Remote sensing of fish stocks.
- 4.4 Factors influencing fish production along the West and East Coast of India.
- 4.5 Fish farmer's development agencies (FFDAs), Fisheries Extension Programs

**Semester IV Theory**  
**Paper Code: SIPSZOOCN42**  
**Paper 2: Marine Biotechnology, Marine Toxicology and Fish Pathology**

***Learning objectives***

- *To keep abreast with the current trends in the fields of Biotechnology, Toxicology and Fish Pathology.*
- *To consider the history, application and, advances in the techniques of Biotechnology in improving fish stock for better yields.*
- *To get acquainted to the principles of toxicology, various toxicants, their movement, and their effects with reference to marine environment.*
- *To familiarize learners with promising Marine Bioactive compounds and their immense potential in various fields of oceanography in order to encourage a multidisciplinary approach.*
- *To gain in depth knowledge about various finfish diseases and the diagnostic techniques for their detection.*

**Unit 1: Marine Biotechnology**

**15 Lectures**

- 1.1 History of marine Biotechnology
- 1.2 Application of biotechnology in aquaculture, pharmaceutical, nutraceutical; Bioremediation, Biofouling, Bio-corrosion, Bio-adhesives.
- 1.3 Advances in cryopreservation of fish gametes
- 1.4 Gene transfer technology in fish: General steps for developing transgenic fish – Gene transfer by microinjection, electroporation, transfer of transgenes by injection with pantropic retroviral viruses, fish antifreeze protein gene, promoter in the production of growth hormone
- 1.5 Characterization of transgenic fish (Identification of transgenic fish and expression of transgenes)
- 1.6 Gene transfer in common carp and channel fish

**Unit 2: Marine Toxicology**

**15 Lectures**

- 2.1 Introduction to toxicology: Brief history, scope, relationship to other sciences, Dose-response relationships, sources, and movements of toxicants in environment)
- 2.2 Basic classification of toxicology, important toxicological terms, types of toxic agents  
Toxicokinetics and Toxicodynamics, Common effects of chemicals, Factors determining the degree of toxicity
- 2.3 Heavy metal toxicity in fishes:  
Heavy metal bioavailability, bioaccumulation, toxicity of Hg, Cd and Pb, Neurotoxic effects, endocrine disruption, effects on locomotive behavior, effects on respiratory behavior, reproductive effect, fish larvae deformities
- 2.4 Phytotoxins in aquaculture
- 2.5 Toxicity caused by agrochemicals

**Unit 3: Marine Bioactive compounds**

**15 Lectures**

- 3.1 Bioactive Metabolites of Marine Algae, Fungi and Bacteria:  
Brominated phenols, Brominated oxygen heterocyclics, Nitrogen heterocyclics, Kainic acids, Guanine derivatives, Phenazine derivatives, Amino acids and amines, Sterols, Sulphated polysaccharides
- 3.2 Bioactive Metabolites of Marine animals:  
Steroids, Terpenoids, Isoprenoids, Prostaglandins, Quinones, Brominated compounds
- 3.3 Marine toxins: Tetrodotoxin, Saxitoxin, Pahutoxin
- 3.4 Biological, Toxicological and Clinical Evaluation:  
Types of Screening, Screening models and activity, Testing methods, Toxicity evaluation, Clinical trials, Use of animals in experiment

**Unit 4: Fish Pathology:**

**15 Lectures**

- 4.1 : Introduction to fish pathology
  - 4.1.1 : Pollutants in the aquatic environment
  - 4.1.2: Adverse biological factors for fish health

- 4.2 : Parasitology of the fish:  
Parasites of the Integument, Eye, Vascular system, Central nervous system, Skeletal system, Alimentary canal
- 4.3 : Bacteriology of the fish:  
Fish pathogenic bacteria belonging to families: Flavobacteriaceae, Enterobacteriaceae, Vibrionaceae, Aeromonadaceae, Pseudomonadaceae, Streptococcaceae (Isolation, Habitat, Morphology, Culture, Epizootiology, Clinical Pathology, Treatment)
- 4.4 : Mycology of the fish:  
Oomycetes (*Saprolegnia* spp., *Aphanomyces* spp., *Brachiomyces* spp., Chytridiomycetes (Chytridiales) Zygomycetes (Entomophthorales) Deuteromycotina (Aspergillomycosis)

**Semester IV – Theory**  
**Paper Code: SIPSZOOCN43**  
**Paper III: Marine Biodiversity Conservation, EIA and CRZ**

***Learning objectives***

- *To make students mindful of the Marine biodiversity and its conservation.*
- *To inculcate the awareness about rich faunal diversity, its distribution, adaptations and conservative measures in marine ecosystems.*
- *To get acquainted to the conservation and management of significant marine habitats.*
- *To get the information about the legislative measures and the norms designed by the government to encourage biodiversity conservation.*
- *To gain in depth knowledge about the Ocean Policies and their management*

**Unit 1: Marine Biodiversity and conservation**

**15 Lectures**

- 1.1 : Introduction to marine biodiversity, Importance, Levels of biodiversity, Definition of extinction of marine bio-resources, Rate of extinction, Causes of extinction
- 1.2 : Marine Reptiles:  
1.2.1 : Sea Turtles- Diversity and distribution, Turtle migrations, Threats, Endangered Species, Conservation  
1.2.2 : Salt-water Crocodiles- Diversity and distribution, adaptations, conservation  
1.2.3: Sea Snakes- Diversity and distribution, adaptations, conservation
- 1.3 : Marine Birds- Diversity and distribution, migration, conservation
- 1.4: Marine Mammals:  
1.4.1: Sirenians- Diversity and distribution, conservation  
1.4.2: Cetaceans- Diversity and distribution, conservation
- 1.5: Conservation and Management of:  
1.5.1: Mangroves and Corals  
1.5.2: Mudflats  
1.5.3: Intertidal regions  
1.5.4: Estuaries and Lagoons

**Unit 2: Biodiversity Conservation laws and marine protected areas of India**

**15 Lectures**

- 2.1 : Conservation and sustainable development, Traditional societies, Government action, Local Legislation
- 2.2 : National laws: National Biodiversity Act and National Biodiversity Authority, Wildlife (Protection) Act, 1972
- 2.3: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- 2.3 : International approaches to conservation and sustainable development, ongoing Problems, possible responses, role of conservation biologists.
- 2.4 : Marine protected areas, designing of protected areas, managing protected areas, restoration ecology
- 2.5 : Marine protected areas of India

### **Unit 3: Environmental impact assessment and Coastal regulatory Zone**

15 Lectures

- 3.1: Introduction - Environmental Impact Assessment (EIA) - types of EIA
- 3.2: Environmental clearance process
- 3.3 : Structure environmental impact assessment - description of project, analysis of alternative site and technology, description of environment - land, water, marine, air, noise and socio-economic occupational health impact. Form I and II.
- 3.4 : Coastal Regulatory Zone Notification: Importance, Changes due to development, Coastal management issues, Comparison between temperate and tropical countries, Integrated coastal zone management, Integrated management.

### **Unit 4: Ocean Policies and Management**

15 Lectures

- 4.1 : Major oceans and their wealth- Three-major Oceans - importance. Historical evolution of open ocean as a common heritage of mankind.
- 4.2 : Law of the Sea- Geneva conventions, UNCLOS, Exclusive Economic Zone (EEZ) and its significance.
- 4.3 : Rules and regulations national and international: mineral deposits. Scientific, Economic, Geo-political aspects of seabed exploration and mining, Seabed treaty
- 4.4 : Role of National and International agencies and organizations in ocean management Intellectual Property Right (IPR) Ocean policy (India).

**Paper code: SIPSZOOCN44**

#### **Paper 4: Research Project / Dissertation**

#### ***Learning objectives***

- to inculcate research aptitude and develop an open, inquiring mind amongst the students
- to encourage students to explore new territories and learn new things
- to encourage the spirit of curiosity of students and to think of research as potential career option
- to motivate and inspire students to come up with solutions for real life problems facing the society and nation

### **M.Sc. Part II – Zoology (Oceanography and Fishery Science)**

#### **Practical's in Semester IV**

#### **Practical - I (SIPSZOOCNP41)**

#### **Based on SIPSZOOCN41**

- 1) Study of food and feeding habits in fish
- 2) Identification of crafts and gears
- 3) Biometric studies of fish/prawn:
  - a) Study of relationship between total length and standard length/ head length/ body depth length/ body weight.
  - b) Calculate correlation (standard length and total length, head length and total length, body depth and total length). Calculate the index values for various relationships.
- 4) Fecundity and maturation studies in fish
- 5) Plotting frequency polygon by ova diameter measurement
- 6) Comparative study of structure of gills in cartilaginous and bony fish
- 7) Crustacean fishery: *Penaeus monodon*, *P. indicus*, *M. monoceros*, *P. stylifera*, *Solenocera indica*, *Nematopaleomon* spp., *Acetes indicus*, *Panulirus polyphagus*, *Scylla serrata*, *Portunus pelagicus*, *Portunus sanguinolentus*, *Charybdis helleri*
- 8) Molluscan fishery: *Meretrix* spp., *Perna viridis*, *Katylisia* spp., *Crassostrea* spp., *Xancus pyrum*, *Solen kempfi*, Cuttle fish and Gastropods
- 9) Identification and classification of marine fish: As per Francis Day's Volume and FAO Identification sheets (Fishing Area 51)
  - a) Elasmobranchs
    1. Family: Carcharidae *Carcharias* spp., *Zygaena malleus*
    2. Family: Rhinobatidae *Rhynchobatus djeddensis*
    3. Family: Trygonidae *Trygon uarnak*



b) Teleost:

1. Family: Percidae- *Lutianus johnii*, *Therapon* spp., *Pristipoma maculatum*, *Synagris japonicus*, *Gerres filamentosus*
  2. Family: Squamipinnes- *Scatophagus argus*
  3. Family: Mullidae- *Upenoides vittatus*
  4. Family: Polynemidae- *Polynemus tetradactylus*
  5. Family: Sciaenidae- *Pseudosciaena diacanthus*, *Sciaena* spp.
  6. Family: Trichiuridae- *Trichiurus savala/haumela*
  7. Family: Carangidae- *Caranx rottleri*, *Chorinemus tolo*
  8. Family: Stromatidae- *Pampus chinensis*, *Pampus argenteus*
  9. Family: Scombridae- *Rastrelliger kanagurta*, *Cybium guttatum*
  10. Family: Trachinidae- *Sillago sihama*
  11. Family: Cottidae- *Platycephalus punctatus*
  12. Family: Gobidae- *Periophthalmus* spp., *Boleophthalmus* spp.
  13. Family: Sphyraenidae- *Sphyraena acutippinis*
  14. Family: Gadidae- *Bregmaceros* spp.
  15. Family: Pleuronectidae- *Psettodes erumei*, *Cynoglossus elongatus*
  16. Family: Scopelidae- *Saurida tumbil*, *Harpodon nehereus*
  17. Family: Sombrosocidae- *Belone stongylurus*, *Hemiramphus* spp.
  18. Family: Clupeidae- *Pellona feligera*, *Clupea longiceps*
  19. Family: Chirocentridae- *Chirocentrus dorab*
  20. Family: Muraenesox- *Muraenesox* spp.
- 10) Student's activity: Visit to local Fish landing centers, Local fish markets, Fishermen villages in and around Mumbai

**Practical - II (SIPSZOOCNP42)**

**Based on SIPSZOOCN42**

- 1) Detection of heavy metals: a) Zinc b) Lead c) Copper
- 2) Identification of Gene transfer technology in fish: General steps for developing transgenic fish – Gene transfer by microinjection, electroporation, transfer of transgenes by injection with pantropic retroviral viruses, FGP
- 3) Identification of fish pathogens
- 4) Identification of microflora using basic microbial techniques
- 5) Qualitative test for assessing bioactive compounds
  - a) Lipids b) Proteins c) Alkaloids d) Terpenoids

**Practical - III (SIPSZOOCNP43)**

**Based on SIPSZOOCN43**

1. Identification of Foraminiferan shells
2. Identification of
  - a) Marine birds
  - b) Marine reptiles
  - c) Marine mammals
3. Case studies based on EIA and CRZ notifications
4. Identification of common mangrove species and associates
5. Identification of common corals species
6. Identification of zooplankton:  
*Noctiluca*, *Obelia*, *Zoea*, Copepods, Mysids, Echinoderm larvae, *Nauplius*, *Sagitta*, *Doliolum*, *Salpa*, Fish eggs and larvae, Jelly fish, *Physalia*, *Porpita*
7. Permanent preparation of zooplankton mountings
8. Student's activity: Visit to coastal areas
9. Student's activity: Shell collection, Algae collection, and preparation of Herbaria

10. Student's activity: Visit to mangrove area (Coastal and Marine Biodiversity Research Center, Vikhroli mangroves)

**Practical - IV (SIPSZOOCNP44)  
based on SIPSZOOCN44**

**Research Project Component based on Oceanography/Fishery Science/Interdisciplinary topic under Zoology**

**Details of Research project component for Semester IV are as follows:**

1. The students will prepare an outline/ scheme of the project proposal based on Oceanography/Fishery Science/Interdisciplinary topic under Zoology in Semester III.
2. A teacher from the department will act as a project mentor to the student.
4. It will be the duty of the mentor to assign to the group a topic related to a particular theme covered in the syllabi / interdisciplinary topic.
6. The mentor will prepare, guide and supervise the group by giving orientation / instructions about writing the project proposal.
7. The **outline / scheme** of the project proposal will include literature review / search, introduction, objectives, purpose and rationale, materials and methods, expected outcomes / results, relevance of the project and bibliography (Note that the students have been taught Research Methodology in the revised syllabus of M.Sc. Part I in the subject of Zoology)
8. Actual execution / practical work of this project is to be done in Semester IV, inclusive of Diwali vacation/Winter vacation and on weekends/holidays of semester IV.
9. Actual execution may involve laboratory/ table work and or field work and or survey (the approach for the project work can be *in vitro* / *in vivo* / *in silico*, among others) as per the specifications mentioned in their project proposal.
10. The mentor for the respective group will keep a track of the actual execution of the project.
11. After completion of the practical work the student will prepare a '**Dissertation**' which will have copy of the outline/scheme of the proposal, abstract/ synopsis of the research work, introduction, materials and methods, observations, interpretation of results, conclusion and discussion, future plan / extension of work.
12. The student will also give a '**Power point presentation**' for the research project.

**Evaluation of Research Project during practical examination for Semester IV will be as follows:**

1. The examiner will evaluate the '**Dissertation**' for the research project by taking into account the following evaluation criteria given below:

<b>Title</b>
Abstract/ synopsis
Materials and Methods
Observations
Interpretation of results
Conclusion and Discussion
Relevance of work

2. The examiner will evaluate the '**Power point presentation**' for the research project by taking into account the following evaluation criteria given below:

<b>Title</b>
Content of the presentation
Quality of the presentation
Presentation skills
Viva/ Question- Answer session

### References for Semester III

#### **Paper I: General, Physical, Chemical, Biological Oceanography**

- 1) Sverdrup, H.U., Johnson, M.W. and Fleming, R.H., 1958. The Oceans- their Physics, Chemistry and General Biology, Prentice- Hall Inc. New Jersey.
- 2) Thurman, H., 2001. Introduction to Oceanography, Prentice Hall Inc. New Jersey.
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- 5) Paul. R. Pinet, 2006. Invitation to Oceanography, 4th Edition. Jones and Bartlett, Sudbury, Massachusetts.
- 6) Garrison, Tom. Oceanography: An invitation to Marine science. 7<sup>th</sup> Edition
- 7) Russel and Young. Seas
- 8) King, C.A.M . Introduction to Physical and Biological oceanography
- 9) Sumich, J.L., 1999. Introduction to the Biology of Marine life. Seventh Edition. The Mc Graw Hill Companies Inc.
- 10) Grasshoff, K., 1999. Methods of Sea water Analysis. Wiley VCH, New York.
- 11) Michael, P. (1984). Ecological methods for field and laboratory investigations. Tata McGraw-Hill.
- 12) Tait, R. V. and DeSanto (1972). Elements of Marine Ecology: An Introductory Course. Spinger Veelag.
- 13) Newell and Newell. Marine plankton
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- 15) Pillai N. Krishna (1986). Introduction to Planktology. Himalaya Publication house Bombay.
- 16) Karleskint, George. Introduction to Marine Biology
- 17) McConnaughey, Bayard H. Introduction to Marine Biology

#### **Paper II: Aquaculture**

- 1) Bardach, et. Al. Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
- 2) Bardach, John E. 1997. Sustainable Aquaculture. John Wiley and Sons.
- 3) Pillay TVR & Kutty M N. 2005. Aquaculture- Principles and Practices. Blackwell.
- 4) Pillay, T.V.R. & M.A. Dill. Advances in Aquaculture. Fishing News (Books) Ltd. England 1979.
- 5) Stickney, 2009. Aquaculture: An Introductory Text. CABI.
- 6) Robert. R. Stickney. Encyclopedia of Aquaculture. A Wiley-Interscience Publication. John Wiley & Sons, Inc.
- 7) Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982.
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- 9) Felix, S. Advances in Shrimp aquaculture management. 2013 Daya publishing house® A Division of Astral International Pvt. Ltd.
- 10) Central Institute of Brackish water Aquaculture, Chennai. Indian Council of Agricultural Research. Training manual on Mud crab breeding and culture
- 11) Food and Agricultural Organization. Mud Crab Culture- A Practical Manual
- 12) Kurian, C.V. & V.O. Sabastian. Prawn and Prawn Fisheries of India. Hindustan Publ. Corp. India, 1982.
- 13) Ramakrishna, Anirudha Dey. Handbook on Indian Freshwater Molluscs
- 14) K.A. Narasimham, V. Kripa. Textbook of Oyster Biology and Culture in India. Indian Council of Agricultural Research, Delhi
- 15) S.D. Tripathi, W.S.Lakra, N.K.Chadha. Aquaculture in India. Narendra Publishing House
- 16) R.A. Dunham. Aquaculture and fisheries biotechnology-Genetic approaches. CABI publishing
- 17) Craig S. Tucker, John A. Hargreaves. Environmental Best Management Practices for Aquaculture. 2008 Blackwell Publishing
- 18) TVR Pillay. Aquaculture and the Environment. Blackwell Publishing Ltd.

- 19) Colin E. Nash. History of Aquaculture. 2011 Blackwell Publishing Ltd.
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### **Paper III: Fish Processing Technology**

- 1) Govindan, T. K. Fish Processing Technology
- 2) Food and Agricultural Organization. Fish handling, Quality and processing: training and community trainers manual
- 3) G.M. Hall. Fish Processing Technology. Blackie Academic and Professional, London
- 4) G.M. Hall. Fish Processing – Sustainability and New Opportunities. © 2011 Blackwell Publishing Ltd.
- 5) Rabinarayan Mishra. Handbook on Fish Processing and Preservation. © 2022 Narendra Publishing House
- 6) Ranendra K. Majumder, Amjad K. Balange. Advances In Fish Processing Technologies. © 2023 by Apple Academic Press, Inc.
- 7) Daniela Borda, Anca Ioana Nicolau, Peter Raspor. Trends in Fish Processing Technologies. © 2018 by Taylor & Francis Group, LLC
- 8) H. Allan Bremner. Safety and quality issues in fish processing. © 2002, Woodhead Publishing Limited
- 9) J.B. Luten, C. Jacobsen, K. Bekaert. Seafood research from fish to dish. © Wageningen Academic Publishers The Netherlands, 2006
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### **References for Semester IV**

#### **Paper I: Fishery Science**

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- 2) A Textbook of Fishery Science and Indian fisheries, Srivastava, C. B. I.
- 3) Khanna, S.S. & H.R. Singh 2006. A Textbook of Fish Biology and Fisheries. Narendra Publ. Hse., India
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- 9) Bone & Marshall. Biology of Fishes. Blackie & Son Ltd., London
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#### **Paper II: Marine Biotechnology, Toxicology and Fish pathology**

- 1) Clark, R.B 1992. Marine pollution. Third edition Clarendon, Press Oxford.
- 2) Williams, 1996. Introduction to Marine Pollution Control. John Wiley.
- 3) Johnston, R., (Ed.), 1976. Marine Pollution, Academic Press, London.
- 4) Kennish, M.J., 1994. Practical handbook on estuarine and marine pollution. Elsevier.
- 5) Y. Le Gal and H. O. Halvorson (Eds). 1997. New Developments in Marine Biotechnology, Plenum Pub. Corp.
- 6) Steven M. Colegate and Russel J. Molyneux. 2008. Bioactive Natural Products (II Ed.). CRC

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- 7) Scheper T. (Ed.). 2005. Marine Biotechnology (Vol. I), Springer (Germany).
- 8) Scheper T. (Ed.). 2005. Marine Biotechnology (Vol. II), Springer (Germany)

### **Paper III: Marine Biodiversity Conservation, EIA and CRZ**

- 1) Young J.Z. 1981. The Life of Vertebrates. Oxford University Press, New Delhi, 645pp.
- 2) Karleskint G., Turner R. and Janes W. Small, Jr. 2013. Introduction to Marine Biology. Brooks/Cole, Cengage Learning, Canada. 563pp.
- 3) Perrin W., Würsig B. and Thewissen J.G.M. (Eds.) 2017. Encyclopedia of Marine Mammals. Academic Press Imprint. 1352 pp.
- 4) Berta A., Sumich J.L. and Kovacs K.M. 2015. Marine Mammals Evolutionary Biology. Elsevier Inc. 726 pp.
- 5) Ghosh, A.K., Alfred, J.R.B and Jonathan, J.K. 1999. Manual Environmental Impact Assessment. Zoological Survey of India, Calcutta. 335pp.
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- 16) Roonwal, G.D. (Ed.) 1986. The Indian Ocean exploited mineral and petroleum resources, Springer Verlag, Berlin.
- 17) Juda, L., 1998. International Law and Ocean Use Management: The Evolution of Ocean Governance. Routl

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**M.Sc. Zoology Syllabus (Autonomous)**  
**Biotechnology-Oceanography and Fishery Science**  
**Credit Based Semester and Grading System**  
**(With effect from academic year 2018-19)**  
**Semester III and Semester IV**

**Scheme of Examination**

The performance of learners will be evaluated in two parts for the Theory component of the Course:

1. Internal Assessment with 40% marks
2. Semester End Examination (written) with 60% marks

The Practical component of the Course will be evaluated by conducting Semester End Practical Examination of 50 marks.

**Internal Assessment Theory (40%)**

It is the assessment of learners on the basis of continuous evaluation as envisaged in the Credit Based System by way of participation of learners in various academic and correlated activities in the given semester of the program.

**Seminar Marks: 20**

Evaluation will be conducted on the basis of Seminar/ Presentation given by the student on a topic chosen from the syllabus for each paper. The marking scheme shall be:

- Content of Presentation: **05 marks**
- Quality of Presentation: **05 marks**
- Presentation skills: **05 marks**
- Question-Answer discussion: **05 marks**

**Assignment Marks: 20**

Evaluation will be conducted on the basis of Research paper review / Book review / Poster presentation / Abstract writing / Preparation of Standard Operating Procedure or Calibration of Instruments / Role play or Skit on topic relevant to the paper / Report on Industry or Field Visit or Writing an article relevant to the paper etc.

**Semester End Assessment Theory (60%)**

**Marks: 60**

**Duration: 2 hours**

**Theory question paper pattern:**

- There shall be five questions of 12 marks each. On each unit there will be one question and the 5<sup>th</sup> question will be based on the entire syllabus.

**OR**

- There shall be four questions of 15 marks each, each question based on one unit.
- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weightage of the topic.

**Semester End Assessment Practical**

**Marks: 50**

**Duration: 5 hours**

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