|  |
| --- |
|  |
| M.Sc.,  MARINE BIOLOGY AND OCEANOGRAPHY |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
| **SYLLABUS**  **FROM THE ACADEMIC YEAR**  **2023 - 2024** |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
|  |
| **TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005** |
|  |

**contents**

1. PO and PSO Description
2. PG – Template
3. Methods of Evaluation & Methods of Assessment
4. Semester Index.
5. Subjects – Core, Elective, Nonmajor, Skill Enhanced, Ability Enhanced, Extension Activity, Environment, Professional Competency
6. Course Lesson Box
7. Course Objectives
8. Units
9. Learning Outcome
10. Refence and Text Books
11. Web Sources
12. PO & PSO Mapping tables

|  |  |
| --- | --- |
| **TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION** | |
| **Programme** | **M.Sc., MARINE BIOLOGY AND OCEANOGRAPHY** |
| **Programme Code** |  |
| **Duration** | **PG - Two Years** |
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**  Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.  **PO2: Decision Making Skill**  Foster analytical and critical thinking abilities for data-based decision-making.  **PO3: Ethical Value**  Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.  **PO4: Communication Skill**  Ability to develop communication, managerial and interpersonal skills.  **PO5: Individual and Team Leadership Skill**  Capability to lead themselves and the team to achieve organizational goals.  **PO6: Employability Skill**  Inculcate contemporary business practices to enhance employability skills in the competitive environment.  **PO7: Entrepreneurial Skill**  Equip with skills and competencies to become an entrepreneur.  **PO8: Contribution to Society**  Succeed in career endeavors and contribute significantly to society.  **PO 9 Multicultural competence**  Possess knowledge of the values and beliefs of multiple cultures and  a global perspective.  **PO 10: Moral and ethical awareness/reasoning**  Ability to embrace moral/ethical values in conducting one’s life. |

|  |  |
| --- | --- |
| **Programme Specific Outcomes**  **(PSOs)** | **PSO1 – Placement**  To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.  **PSO 2 - Entrepreneur**  To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.  **PSO3 – Research and Development**  Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.  **PSO4 – Contribution to Business World**  To produce employable, ethical and innovative professionals to sustain in the dynamic business world.  **PSO 5 – Contribution to the Society**  To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

**Template for P.G., Programmes**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester–I** | **Credit** | **Hours** | **Semester-II** | **Credit** | **Hours** | **Semester-III** | **Credit** | **Hours** | **Semester–IV** | **Credit** | **Hours** |
| 1.1. Core-I | 5 | 7 | 2.1. Core-IV | 5 | 6 | 3.1. Core-VII | 5 | 6 | 4.1. Core-XI | 5 | 6 |
| 1.2 Core-II | 5 | 7 | 2.2 Core-V | 5 | 6 | 3.2 Core-VII | 5 | 6 | 4.2 Core-XII | 5 | 6 |
| 1.3 Core – III | 4 | 6 | 2.3 Core – VI | 4 | 6 | 3.3 Core – IX | 5 | 6 | 4.3 Project with viva voce | 7 | 10 |
| 1.4 Discipline Centric  Elective -I | 3 | 5 | 2.4 Discipline Centric  Elective – III | 3 | 4 | 3.4 Core – X | 4 | 6 | 4.4Elective - VI (Industry / Entrepreneurship)  20% Theory  80% Practical | 3 | 4 |
| 1.5 Generic Elective-II: | 3 | 5 | 2.5 Generic Elective -IV: | 3 | 4 | 3.5 Discipline Centric Elective - V | 3 | 3 | 4.5 Skill Enhancement course / Professional Competency Skill | 2 | 4 |
|  |  |  | 2.6 NME I | 2 | 4 | 3.6 NME II | 2 | 3 | 4.6 Extension Activity | 1 |  |
|  |  |  |  |  |  | 3.7 Internship/ Industrial Activity | 2 | - |  |  |  |
|  | **20** | **30** |  | **22** | **30** |  | **26** | **30** |  | **23** | **30** |
| **Total Credit Points -91** | | | | | | | | | | | |

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System**

**for all Post – Graduate Courses including Lab Hours**

**First Year – Semester – I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – I | 5 | 7 |
| Core – II | 5 | 7 |
| Core – III | 4 | 6 |
| Elective – I | 3 | 5 |
| Elective – II | 3 | 5 |
|  |  | **20** | **30** |

**Semester-II**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – IV | 5 | 6 |
| Core – V | 5 | 6 |
| Core – VI | 4 | 6 |
| Elective – III | 3 | 4 |
| Elective – IV | 3 | 4 |
| Skill Enhancement Course [SEC] - I | 2 | 4 |
|  |  | **22** | **30** |

**Second Year – Semester – III**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – VII | 5 | 6 |
| Core – VIII | 5 | 6 |
| Core – IX | 5 | 6 |
| Core (Industry Module) – X | 4 | 6 |
| Elective – V | 3 | 3 |
| Skill Enhancement Course - II | 2 | 3 |
|  | Internship / Industrial Activity [Credits] | 2 | - |
|  |  | **26** | **30** |

**Semester-IV**

|  |  |  |  |
| --- | --- | --- | --- |
| **Part** | **List of Courses** | **Credits** | **No. of Hours** |
|  | Core – XI | 5 | 6 |
| Core – XII | 5 | 6 |
| Project with VIVA VOCE | 7 | 10 |
| Elective – VI (Industry Entrepreneurship) | 3 | 4 |
| Skill Enhancement Course – III / Professional Competency Skill | 2 | 4 |
| Extension Activity | 1 | - |
|  |  | **23** | **30** |

**Total 91 Credits for PG Courses**

|  |  |  |  |
| --- | --- | --- | --- |
| **METHODS OF EVALUATION** | | | |
| **Internal Evaluation** | Continuous Internal Assessment Test | | **25 Marks** |
| Assignments / Snap Test / Quiz | |
| Seminars | |
| Attendance and Class Participation | |
| **External Evaluation** | End Semester Examination | | **75 Marks** |
| **Total** | | | **100 Marks** |
| **METHODS OF ASSESSMENT** | | | |
| **Remembering (K1)** | | * Thelowestlevelofquestionsrequirestudentstorecallinformationfromthecoursecontent * Knowledgequestionsusuallyrequirestudentstoidentifyinformationinthetextbook. | |
| **Understanding (K2)** | | * Understandingoffactsandideasbycomprehendingorganizing,comparing,translating,interpolatingandinterpretingintheirownwords. * Thequestionsgobeyondsimplerecallandrequirestudentstocombinedatatogether | |
| **Application (K3)** | | * Studentshavetosolveproblemsbyusing/applyingaconceptlearnedintheclassroom. * Studentsmust usetheir knowledgetodetermineaexactresponse. | |
| **Analyze (K4)** | | * Analyzingthequestionisonethatasksthestudentstobreakdownsomethingintoitscomponentparts. * Analyzingrequiresstudentstoidentifyreasonscausesormotivesandreachconclusionsorgeneralizations. | |
| **Evaluate (K5)** | | * Evaluationrequiresanindividualtomakejudgmentonsomething. * Questionstobeaskedtojudgethevalueofanidea,acharacter,aworkofart,orasolutiontoaproblem. * Studentsareengagedindecision-makingandproblem–solving. * Evaluationquestionsdonothavesinglerightanswers. | |
| **Create (K6)** | | * Thequestionsofthiscategorychallengestudentstogetengagedincreativeandoriginalthinking. * Developingoriginalideasandproblemsolvingskills | |

**PROGRAMME OUTCOMES (PO) - PROGRAMME SPECIFIC OUTCOMES (PSO) MAPPING**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **PROGRAMME SPECIFIC OUTCOMES (PSO)** | | | | | |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** |
| **PSO1** | **3** | **3** | **3** | **3** | **3** |
| **PSO2** | **3** | **3** | **3** | **3** | **3** |
| **PSO3** | **3** | **3** | **3** | **3** | **3** |
| **PSO4** | **3** | **3** | **3** | **3** | **3** |
| **PSO5** | **3** | **3** | **3** | **3** | **3** |

**Level of Correlation between PO’s and PSO’s**

*(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)*

Assign the value

**1 – Low**

**2 – Medium**

**3 – High**

**0 – No Correlation**

**M.Sc. Marine Biology and Oceanography Programme**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Course Title** | **Hours/ Week** | | **C** | **Marks** | | |
| **L** | **P** | **CIA** | **ESE** | **Total** |
| **Semester-I** | | | | | | | |
| . Core-I | Invertebrates and Prochordates | 7 |  | 5 | 25 | 75 | 100 |
| Core-II | Vertebrates | 7 |  | 5 | 25 | 75 | 100 |
| Core – III | Cytology, Genetics and Immunology | 6 |  | 4 | 25 | 75 | 100 |
|  | Practical–I Practical–II |  |  |  | 25 | 75 | 100 |
| Discipline Centric  Elective -I | Marine Microbiology | 5 |  | 3 | 25 | 75 | 100 |
| Generic Elective-II: | Physiology and Biochemistry | 5 |  | 3 | 25 | 75 | 100 |
|  |  | **30** |  | **20** |  |  |  |
| **Semester-II** | | | | | | | |
| Core-IV | Physical Oceanography | 6 |  | 5 | 25 | 75 | 100 |
| Core-V | Chemical Oceanography | 6 |  | 5 | 25 | 75 | 100 |
| Core – VI | Biological Oceanography | 6 |  | 4 | 25 | 75 | 100 |
|  | Practical–III, Practical–IV,  Practical–V |  |  |  | 25 | 75 | 100 |
| Discipline Centric  Elective – III | Coastal Aquaculture | 4 |  | 3 | 25 | 75 | 100 |
| Generic Elective -IV: | Fisheries Science and Statistics | 4 |  | 3 | 40 | 60 | 100 |
| NME I | Environmental Studies | 4 |  | 2 | 40 | 60 | 100 |
|  |  | **30** |  | **22** | 40 | 60 | 100 |
|  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Semester-III** | | | | | | | |
| Core-VII | Marine Ecology & Zoogeography | 6 |  | 5 | 25 | 75 | 100 |
| Core-VIII | Marine Biotechnology, | 6 |  | 5 | 25 | 75 | 100 |
| Core – IX | Pollution and Toxicology | 6 |  | 5 | 25 | 75 | 100 |
| Core – X | Ocean Management | 6 |  | 4 | 25 | 75 | 100 |
|  | Practical–VI , Practical–VII |  |  |  | 25 | 75 | 100 |
| Discipline Centric Elective - V | Elective–II(DE) | 3 |  | 3 | 25 | 75 | 100 |
| NME II | Elective–III(DE) | 3 |  | 2 | 40 | 60 | 100 |
| Internship | Industrial Activity |  |  | 2 | 40 | 60 | 100 |
|  |  | **30** |  | **26** |  |  |  |
| **Semester-IV** | | | | | | | |
| Core-XI | Ornamental Fish culture & Aquarium Keeping | 6 |  | 5 | 25 | 75 | 100 |
| Core-XII | Bioinformatics & Instrumentation | 6 |  | 5 | 25 | 75 | 100 |
| Project with viva voce | Project Work | 10 |  | 7 | 25 | 75 | 100 |
| Elective - VI | (Industry / Entrepreneurship) 20% Theory 80% Practical | 4 |  | 3 | 30 | 70 | 100 |
| Skill Enhancement course / Professional Competency Skill |  | 4 |  | 2 |  |  |  |
| Extension Activity |  |  |  | 1 |  |  |  |
|  |  |  |  |  |  |  |  |
|  | **Total Credits** |  |  | **91** |  |  |  |

**ElectiveCourses**

**DepartmentElectives (DE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CourseTitle** | **Hours/Week** | | **C** | **Marks** | | |
| **L** | **P** | **CIA** | **ESE** | **Total** |
| **DisasterManagement** | **3** |  | **3** | **25** | **75** | **100** |
| **MarineFoodTechnology** | **3** |  | **3** | **25** | **75** | **100** |
| **MicrobialTechnology** | **3** |  | **3** | **25** | **75** | **100** |
| **RemoteSensing** | **3** |  | **3** | **25** | **75** | **100** |

**InterDepartmentalElectives(IDE)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CourseTitle** | **Hours/Week** | | **C** | **Marks** | | |
| **L** | **P** | **CIA** | **ESE** | **Total** |
| **SoftSkillDevelopment** | **3** |  | **3** | **25** | **75** | **100** |

**Semester-I INVERTEBRATESANDPROCHORDATES**

**(Functionalmorphology,PalaeontologyandEvolution) Credits:3**

**Hours:3**

**LearningObjective3LO):**

## LearningObjective(LO):

**LO1:**TounderstandGeologicaltimescale,chordatefeaturesandtheoriesonoriginofchordates.

**LO2:**Tolearnaboutoriginanddistributionofamphibia**.**

**LO3:**Tounderstandadaptiveradiationofcontemporaryreptiles,turtlesandamphibian.

**LO4:**Tolearnthegeneralcharactersofmammalsandevolutionofmonotremes,marsupialsand placentals.

**LO5:**Tounderstandgamatogenesis,fertilization,cleavageanddevelopmentuptogastrulationin Amphioxus.

## UNIT1–ProtozoaandCoelenterata

Classification – Morphology – Reproduction - life history and phylogenetic relationships of Protozoa and sponges.

Coelenterate – polymorphism, life history, theories on coral reefs, distribution.Structure, Ecosystem & formation.

## UNIT2–Minorphyla

Functional morphology, development and evolution: Nemertinea, Endoprocta, Ectoprocta, Phoronida and Pogonophora.

Chaetognatha–classification,distribution,morphology,anatomy,embryologyand evolution. Brachiopoda -classification, morphology, palaeontology and evolution.

## UNIT3–CrustaceaandPolychaeta

Crustacea:Classification,comparative morphology, crustacean appendages, larval forms, evolution and palaeontology.

Polychaeta–classification,morphology,feedingmethods-reproductionandadaptive radiation.

## UNIT4-Mollusca

Classification, general characters, torsion, palaeontology, phylogenetic relationships and adaptive radiation, reproduction and embrogeny.

## UNIT5–EchinodermataandProchordata

Echinodermata–Classification,structureand function,watervascularsystem, regeneration, reproduction and larval forms.

Prochordata–classificationandcomparativemorphology,reproductionandearly development, larval metamorphosis.

## Practical

1. Identificationoflocallyavailableinvertebratefauna
2. Mountingofgastropodradula
3. Digestivesystemingastropodsandbivalves
4. Crystallinestyleofbivalves
5. Identificationofsexincrustaceansandmolluscs
6. Mouthpartsof*Squilla*and*Balanus*.
7. Study of digestive,nervous, reproductive systems and different ovarian maturity stages in Shrimp
8. Appendagesofprawns,shrimpsandcrabs
9. Studyofwatervascularsystem,tubefeetandAristotle’slanterninseastars

## TextBooks

1. Hyman,l.,1967.TheInvertebratesVols,ItoVI.McGrawHillBookCo.Ltd.,New York, 792 pp.
2. Kaestner,A.,1967-1970InvertebrateZoologyVols.1-(1967-472pp),Vol.2(1968- 472pp)Vol.3 (1970-523pp). Wiley Interscience Publishers, New York.
3. Barnes,R.D.,1980.InvertebrateZoology.4thEdition.SaundersCollegePublishers, Philadelphia, 534 pp.
4. Ruppert, E.E.andR.D. Barnes,1994.Invertebrate Zoology6thEdition.Saunders College Publishers, Philadelphia, 1056 pp.
5. Adiyodi,K.G. andK.G.Adiyodi, 1994. Reproductive Biology of Invertebrates, Vol -5, Johnwiley&Sons,New York 542 pp.
6. Rupert,E.E.,R.S.Fox and R.D.Barnes., 2006. Invertebrate Zoology. 7th Edition. Saunders College Publishers, Philadelphia, 828 pp.
7. Kotpal,R.L.2009.ModernTextbook ofZoologyinvertebrates.10thEdition.Rostogi publications, Meerut.
8. Nair N. C., S. Leelavathy, N .Soundrapandian, T. Murugan, N, Arumugam, 2010. A text book of Invertebrates. Saras Publication, Nagercoil. 752 pp.

## SupplementaryReading

* 1. JamesR.GareyandAndreasSchmidt-Rhaesa31998).TheEssentialRoleOf"Minor" Phyla In Molecular Studies Of Animal Evolution. Amer. Zool., 38:907-917.
  2. Yasunori Kano, Satoshi Chibaand Tomoki Kase (2002). Major adaptive radiation in neritopsinegastropodsestimatedfrom28SrRNAsequencesandfossilrecords.*TheRoyal Society.*

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | TounderstandtheclassificationofPhylum:Coelenterates/Cnidariaandthedevelopment  ofmetamorphosis. |
| CO2: | Tounderstandthefunctionalmorphologyofminorphylaandtheirclassification&  development. |
| CO3: | TounderstandtheclassificationofCrustaceaandPolychaeteswiththeirdevelopmental  stages. |
| CO4: | TounderstandtheclassificationandimportanceofPhylumMollusca. |
| CO5: | TounderstandtheclassificationofEchinodermataandProchordatawiththeir  development. |

## OutcomeMapping

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | 3 | 3 | 3 |  | 3 | 3 |  |
| **CO2** | 3 | 3 | 3 |  | 3 | 3 |  |
| **CO3** | 3 | 3 |  | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 |  | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Total** | **15** | **15** | **9** | **9** | **15** | **15** | **9** |

**Semester-I VERTEBRATES Credits:3**

**(Functionalmorphology,Palaeontology,DevelopmentalBiologyandEvolution) Hours:3**

## LearningObjective(LO):

**LO1:**TounderstandGeologicaltimescale,chordatefeaturesandtheoriesonoriginofchordates.

**LO2:**Tolearnaboutoriginanddistributionofamphibia**.**

**LO3:**Tounderstandadaptiveradiationofcontemporaryreptiles,turtlesandamphibian.

**LO4:**Tolearnthegeneralcharactersofmammalsandevolutionofmonotremes,marsupialsand placentals.

**LO5:**Tounderstandgamatogenesis,fertilization,cleavageanddevelopmentuptogastrulationin Amphioxus.

## UNIT1–Originofchordates

Geological time scale – progression of vertebrates through time, chordate features and theories on the origin of chordates.

## UNIT2–BonyfishesandAmphibia

Characteristic features of ancestral vertebrates – classification and evolution of jawless and primitive vertebrates. Evolution and adaptive radiation of elasmobranchs and bony fishes. Connecting link (Dipnoi).

Origin and distribution of amphibia – anatomical peculiarities and affinities of Urodela and Apoda.

## UNIT3–ReptilesandMarinebirds

Origin of reptiles – adaptive radiation of contemporary reptiles, turtles, amphibian and reptilian features of *Seymouria*, mammal-like reptiles, rise and fall of dinosaurs including mesozoic marine reptiles.

Mosasaurs, the giant marine lizards.Marine Crocodile: Estuarine/Salt water crocodile,Sea snakes

Importanceofmarinebirds,adaptationstothemarineenvironment,migration.

## UNIT4–EvolutionofMammalsandhuman

Generalcharactersof mammals–classificationand evolutionof monotremes, marsupials andplacentals, humanevolution,aquatic mammals–classification,adaptationsandevolutionof Cetacea and Sirenia. Seals, Walruses and Sea otters.

Aquatic adaptations for respiratory and circulatory mechanisms – comparative anatomy of skin derivatives.

## UNIT5–DevelopmentalBiology

Gametogenesis,fertilization,cleavage,developmentuptogastrulationinAmphioxus.

Embryology(withspecialreferencetomarinevertebratesviz.,fish,birdandmammal).

## Practical

1. Functional morphologyofrespiratoryorgans- aquaticanimals- gillsof cartilagenousand bony fishes
2. StudyofimportantvertebratesspecimenrepresentingphylumPiscestoMammalia
3. Earlyembryonicdevelopmentalstagesoffish.-Larvalstages
4. Mountingofscalesoffishes.
5. Baleenplatesofwhales
6. Osteologicalobservationoffishesandmarinemammals
7. Marineturtles
   1. Greenturtle
   2. Oliverridleyturtle
   3. Hawksbillturtle
   4. Leatheryturtle
   5. Loggerheadturtle
8. Preparationoffieldreport.

## TextBooks

1. RobertT. Orr,1976.VertebrateBiology.3rd Edition,W.B.SaundersCompany, Philadelphia

p.472.

1. Young,J.Z.,1981.TheLifeofVertebrates.OxfordUniversityPress,NewYork,568pp.
2. Minkoff,E.C.,1983.EvolutionaryBiology,AddisonWesleyPublishingCompany,Massachusetts, 627 pp.
3. Romer, A.S. and T.S.Parsons, 1986. The Vertebrate body, 6th edition, Philadelphia Soundrs VII + 679pp.
4. Colbert,Edwin,H.1989.Evolutionofthevertebrates.WileyEasternLtd.,NewDelhi.P. 535.
5. Strickberger, W. Monroe, 1996. Evolution. Jones and Barlett Publishers, Massachusetts, p.670.
6. Gilbert,F.Scott,2000.DevelopmentalBiology,6thedition,SinauerAssociates,Inc., Publishers, Massachusetts, p. 749.
7. KennethKardong, 2001. Vertebrates; Comparative anatomyfunction, evoluation. McGraw Hill Science 3rd edition, 784pp.
8. Edward,J.Z.,2006.ComparativeVertebrateanatomy: alaboratorydissectionguide. McGraw Hill, 226p.

## SupplementaryReading

* 1. Colbert,E.H.,2015.EvolutionOfVertebrates(510Pp).
  2. Seshappa,G.,2018.IndianMarineBiology(154pp).
  3. GeorgeL.HuntJr.,1990.Thepelagicdistributionofmarinebirdsinaheterogeneous environment. Polar Research, 8:1, 43-54.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandtheoriginofchordatesbytimescaleandfeatures. |
| CO2: | TounderstandtheoriginofAmphibiaandBonyfishes. |
| CO3: | TounderstandtheoriginandadaptiveradiationofReptilesandBirds. |
| CO4: | TounderstandtheevaluationofMarineMammalsandhuman. |
| CO5: | Tounderstandthemarinedevelopmentalstagesofvertebrate’sviz.,fish,birdand  mammals. |

## OutcomeMapping

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  |  |
| **CO2** | **3** | **3** | **3** | **3** |  |  |  |  | **3** | **3** |  |  |
| **CO3** | **3** | **3** | **3** | **3** |  | **3** |  |  |  | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** | **3** | **3** |  |  |
| **CO2** |  |  |  | **3** | **3** |  |  |
| **CO3** | **3** |  |  |  | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** |  | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** |  |
| **Total** | **12** | **9** | **9** | **9** | **15** | **09** | **06** |

**Semester-ICYTOLOGY,GENETICSANDIMMUNOLOGY**

**Credits:4**

**Hours:4**

## LearningObjective(LO):

**LO1:**Tolearnaboutmicroscopes- light,phasecontrastandinterference,darkfield, fluorescence, confocal electron (TEM and SEM).

**LO2:** To learn about the principles of genetics, practical applications of genetics, hybridization of fishes and recent trends.

**LO3:**Tolearnaboutnormalandtransformedcelllinesasmodelgeneticsystemsand advantages.

**LO4:**Tolearnaboutnon-specificimmuneresponse,Immunologicalfactors-humoraland clotting.

**LO5:**TolearnabouttheelementsofImmunolgy,Antigen,antigenicity,epitopesandhaptens.

## UNITI–Microscopyandcellularorganisation

Microscopy - light, phase contrast and interference, darkfield, fluorescence, confocal, electron (TEM and SEM), electron tunneling and atomic force microscopy.

Structural organization of cells-nucleus, ultrastructure of cytoskeleton, microtubules, micro-filaments, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes and peroxisomes and extracellular matrix – collagen, elastin, fibrilin, fibronectin, laminin and proteoglycans.

## UNITII–Genetictechniques

Principles of genetics, environmental influences, practical applications of genetics – hybridization of fishes, recent trends and techniques in hybridization, selective breeding, cross breeding, development of disease resistance and high quality new strains, transgenic fish production.

Chromosome manipulation –androgenesis, gynogenesis, sex reversaland ploidy. aquaculture applications, Cryopreservation, conservation of germplasm.

## UNITIII-Modelgeneticssystems

Model genetic systems – T4 and phages; Neurospora; *E.coli*and Saccharomyces cerevisiae; Drosophila; Zebra fish – advantages.

Normalandtransformedcelllinesasmodelgeneticsystems–advantages.

## UNITIV–Immunology–Invertebrates(Crustaceans)

Non-specific immune response; Immunological factors – humoral and clotting; Cellular components;*Chemical constituents*– haemocyaninand total protein; Osmality and electrolytes; Glucose and other energy components, acid-base balance, tissue enzymes and hormones.

## UNITV–Immunology–Vertebrates(fish)

Elements of Immunology; Antigen, antigenicity, epitope and haptens; Cells of lymphoretocular system; Antibody production; *Immunoglobulins* – structure, function, classes, allotypes and isotypes; Innate and acquired immunity; Vaccines; Monoclonal and polyclonal antibodies.

## Practical

1. Demonstration and operation of principles of light, compound, phase contrast and electronmicroscope
2. Giantchromosomalpreparation(Squash)
3. TypesofCells
4. Preparationofstagesofcelldivision
5. Cellorganelles(Slides)
6. Fishchromosomemounting
7. Bloodcellcountandidentificationoflymphoidcellsinbloodsmears
8. Antigenandantibodyreaction&Haemagglutination
9. Immunoelectrophoretictechniques
10. ELISA
11. Celldivision–MitosisandMeiosis
12. CalibrationanduseofStageandOcularMicrometersandMeasuringmicroscopicorganisms

# TEXTBOOKS

* 1. Strachan,T.andA.P.Read, 2004.HumanMolecularGenetics,3rdEdition,Wiley Publications, 674pp.
  2. Gahalain,S.S.,2004FundamentalsofGenetics,AnmolPublicationsPvt.Ltd.,603pp.
  3. Sambamurthy,A.V.V.S.2005,Genetics,AlphaScienceInternational,9003pp.
  4. Male,D.,Brostoff,J.,Roth,D.B.,Roitt,M.I.2006Immunology,ElsevierPublications, 552pp, 7th Edition.
  5. Prakash,M.2007MolecularGenetics,DiscoveryPublishingHouse,NewDelhi,332pp.
  6. Lodish,HarveyF.2008,MolecularCellBiology,W.H.Freeman&Company,973pp.
  7. GeraldKarp,2009,CellandMolecularBiology,WileyPublications,832pp.
  8. Peter,J.D.andI.M.Roitt,2011.Roitt’sessentialImmunology,Wiley –Blackwell, 12th edition, 546 pp.
  9. AbdulK.appas,AndrewH.Lichtman,S.Pillai,2011CellularandMolecular Immunology, Elsevier Publications, 592pp.
  10. Pandian,T.J.,2011.Sexdeterminationinfish,CRCPressLondon,277pp.

# SUPPLEMENTARYREADING

1. Paul,W.E.,2013.FundamentalImmunology(1283pp).
2. GeraldKarp.2014.CellBiology(783pp).
3. CharlesF.Wimpee,Tracie-LynnNadeauandKennethH.Nealson,1991.Development of Species-Specific Hybridization Probes for Marine Luminous Bacteria By Using In Vitro Dna Amplification. Applied And Environmental Microbiology. 1319-1324 pp.
4. WilliamJ.Wiebe1AndGeorgeB.Chapman,1968.VariationInTheFineStructureOfA Marine Achromobacter and a Marine Pseudomonad Grown Under Selected Nutritional and Temperature Regimes. *Journal Of Bacteriology*. 1874-1886 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthemicroscopes-light,phasecontrastandinterference,darkfield,  fluorescence,confocalelectron3TEMandSEM). |
| CO2: | Tounderstandtheprinciplesofgenetics,practical applicationsof genetics, hybridization  offishesandrecenttrends. |
| CO3: | Tounderstandthenormalandtransformedcelllinesasmodelgeneticsystemsand  advantages. |
| CO4: | Tounderstandthenon-specificimmuneresponse,Immunologicalfactors-humoraland  clotting. |
| CO5: | TounderstandtheelementsofImmunology,Antigen,antigenicity,epitopesandhaptens. |

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  |  |  |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** |  |  | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  |  |  |  |
| **CO3** | **3** | **3** |  | **3** |  |  | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **15** | **09** | **09** | **09** | **09** | **09** |

**Semester-I MARINEMICROBIOLOGY**

**Credits:3**

**Hours:3**

## LearningObjective(LO):

**LO1:** To learn about the occurrence, distribution, structure and biology of marine bacteria. **LO2:**Tolearnabouttheoccurrence,distribution,structureandbiologyofmarinecyanobacteria. **LO3:** To learn about the occurrence, distribution, structure and biology of actionmycetes

**LO4:**Tolearnabouttheoccurrence,distribution,structureandbiologyofmarinefungi.

**LO5:**Tolearnabouttheoccurrence,distribution,structureandbiologyofmarineviruses.

## UnitI-Ecologyofmarinebacteria

Occurrenceanddistribution,structureandbiology,ecologicalrole,economic significance.

## UnitII-Ecologyofmarinecyanobacteria

Occurrenceanddistribution,structureandbiology,ecologicalrole,economic significance.

## UnitIII-Ecologyofmarineactinomycetes

Occurrenceanddistribution,structureandbiology,ecologicalrole,economic significance.

## UnitIV-Ecologyofmarinefungi

Occurrenceanddistribution,structureandbiology,ecologicalrole,economic significance.

## UnitV-Ecologyofmarineviruses

Occurrenceanddistribution,structureandbiology,ecologicalrole,economic significance.

## Practical

1. PreparationofMedia
2. Estimationofbacterialpopulationfrommarinesamples
3. Pure culture techniques Phase streaking Continuousstreaking ‘T’ streaking

Radialstreaking

1. Identificationofunknownbacteria

Motilityofbacteria–hangingdropmethod/semisolidmedium Gram’s staining

IMViC

Triplesugarironagar Starch hydrolysis Casein hydrolysis

Carbohydrateutilizationtest

1. Isolationofcyanobacteria
2. Identificationofcyanobacteria-morphological
3. Isolationofactinomycetes
4. Identificationofactinomycetes–morphological
5. Isolationoffungifrommarinesamples
6. Identificationoffungi–morphological
7. Isolationofbacteriophages
8. Onestepgrowthofbacteriophages
9. Preparationofbacteriophagestocks
10. Titrationofbacteriophages
11. Purificationofphage

# TEXTBOOKS

* 1. Lederberg,H.,1992.EncyclopediaofMicrobiology,Vol.1-4.,AcademicPress,NY.1154 pp.
  2. Dube,H.C.,1994.ATextbookofFungi,BacteriaandViruses,VikasPublishing House,India 240 pp.
  3. Mckane,L.andJ.Kandel,1996.Microbiology,EssentialsandApplications.McGrawHill Inc., New York, 843 pp.
  4. AustinB.anD.A.Austin,1996BacterialFishPathogens-DiseasesofFarmedandWild Fish, Springer Praxis Publishing, 457 pp.
  5. Stickney,B.R.,2000.EncyclopediaofAquaculture.JohnWiley&Sons,Inc,US.1063 pp.
  6. Munn,C.B.2004. Microbial ecology: ecology and applications.BIOS Sci., Pub., US.,282pp.
  7. Kirchman,D.L.,2008.MicrobialecologyoftheoceansJohnWiley&sonsUS593pp.

# SUPPLEMENTARYREADING

1. KimS.K.,2013.MarineMicrobiology:BioaciveCompoundsAndBiotechnological Applications (549 pp).
2. Thatoi,H.,R.R.Mishra,B.C.Behra,2018.MangroveMicroorganisms:Biodiversity And Biotechnology (173 pp).
3. PaulR.Jensen,RyanDwight,AndWilliamFenical,1991.DistributionofActinomycetes in Near-Shore Tropical Marine Sediments. *Applied and Environmental Microbiology*. 1102-1108 pp.
4. KuiHong,An-HuiGao,Qing-YiXie,HaoGao,LingZhuang,Hai-PengLin,Hai-Peng Lin, Hai-Ping Yu, Jia Li, Xin-Sheng Yao, Michael Goodfellow Michael Goodfellow, 2009. Actinomycetes for Marine Drug Discovery Isolated from Mangrove Soils and Plants in China. *Mar. Drugs. 7*, 24-44 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandtheoccurrence,distribution,structureandbiologyofmarinebacteria. |
| CO2: | To understand the occurrence, distribution, structure and biology of marine  cyanobacteria. |
| CO3: | Tounderstandtheoccurrence,distribution,structureandbiologyofactionmycetes. |
| CO4: | Tounderstandtheoccurrence,distribution,structureandbiologyofmarinefungi. |
| CO5: | Tounderstandtheoccurrence,distribution,structureandbiologyofmarineviruses |

## OutcomeMapping

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** |  | **3** |  | **3** |  |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** |  |  | **3** |  |  | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** |  |  | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  | **3** |  |  |
| **CO3** | **3** |  |  | **3** |  |  | **3** |
| **CO4** | **3** | **3** |  | **3** |  |  | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **09** | **09** | **09** | **09** | **09** | **09** |

**Semester-I PHYSIOLOGYANDBIOCHEMISTRY**

**Credits:4**

**Hours:4**

## LearningObjective(LO):

**LO1:**Tolearnthephysiologyoffeeding,feedingmechanism,passageoffood,digestiveenzymes and their role with food habits.

**LO2:** To learn about physiology of rhythms- circadian, tidal andlunar rhythmsinmarine andestuarine animals.

**LO3:** Tolearnaboutthephysiologyofnervoussystem-autonomicnervoussystemin elasmobranchs and bony fishes.

**LO4:**Tolearnaboutthemajorbiomolecules–classification-carbohydrates,proteins,amino acids, lipids and fatty acids.

**LO5:**TolearntheMetobolismofcarbohydrates,aminoacidsandbiosynthesisofnucleicacids.

## UNIT1–PhysiologyofFeedingandRespiration

Physiologyoffeeding,feedingmechanisms,passageoffood,digestiveenzymesandtheir role with food habits. Respiratory structures and functions –Accessory respiratory organs, swim/air bladders, factorsaffecting respiration, structure and function of blood pigments, role of transport of O2 and CO2.

## UNIT2–OsmoregulationandBiorhythms

Physiology of ionic and osmoregulations – ions in body fluids, mechanism of ionic regulation, responses to osmotic conditions, types of osmoregulatory adaptations.

Physiology of rhythms – circadian, tidal and lunar rhythms in marine and estuarine animals, environmental factors responsible for biorhythms, significance of biorhythms. Tidal, vertical and horizontal migration of larvae, larval release rhythm and larval behaviour of crustaceans, crustacean larval phototaxis & its functional significance. Physiologyof bioluminescence in marine organisms – its significance.

## UNIT3–NervousandEndocrinesystems

Physiology of nervous system – autonomic nervous system in elasmobranchs and bony fishes, impulse generation and conduction, interneuronic transmission, integration of information. Physiology of Endocrine system – hormones, neurohormones, hormones of reproduction in finfishes and shell fishes, hormone induced colour change in crustaceans. Moulting in crustaceans.

## UNIT4–Biomolecules

Major biomolecules - classification – carbohydrates, proteins, amino acids, lipids and fatty acids – structure properties and function. Enzymes -nature, classification and mechanism of action, factors affecting enzyme activity, enzyme kinetics. Nucleic acids – composition, structure and function.

## UNIT5–MetabolismandBiosynthesis

Metobolism of carbohydrates - Glycolysis, glyconeogenesis, citric acid cycle.Metabolism of amino acids-Nitrogen transamination, determination and Urea cycle. Fatty acid metabolism – Oxidation and biosynthesis. Biosynthesis of nucleic acids.

## Practical

1. Chromatophorechangeduetolightanddarkadaptationsinintertidalcrabs.
2. Effectofhydrogenionconcentrationonamylaseactivityofthecrystallinestylefrombivalve.
3. Effectoftemperature–therateofparticletransportinbivalves
4. Effectofsalinityonrespirationoffish/bivalve
5. Effectofsalinityonosmoticconcentration(osmoregulation)offish.
6. DisplayofNeuroendocrineorgansinacrustacean.
7. Estimation of totalprotein,carbohydrates, lipids, moisture content, calorific valve and ash content.
8. Separationofphospholipidusingthinlayerchromatography.
9. Separationoffreeandboundaminoacidsusingpaperchromatography.

# TEXTBOOKS

1. Prosser, C.L., 1973. Comparative Animal Physiology, 3rd edition, W.B.Saunders, Philadelphia, 966 pp.
2. Vernberg, F.J. and W.B.Vernberg,1974. Pollution andPhysiology of Marine Organisms. Academic Press,NY. 492 pp.
3. Palmer, J.D., F.A. Brown and L.N. Edmunds, 1976. An Introduction of Biological Rhythms. Academic Press Inc., New York.375pp.
4. Vernberg,F.J and W.B.Vernberg,1983.TheBiologyofCrustaceavol.8, Environmental adaptations, Academic Press New York. 383 pp.
5. Withers, P.C.,1992.Comparative Animal Physiology. Fostworth, TX: Saunders College Publishing, Philadelphia 949pp.
6. Lehninger, A.L., D.L. Nelson and M.M. Cox, 1993. Principles of Biochemistry. CBS Publishers & Distributors, New Delhi, 1013 pp.
7. Baldwin, E., 1996. Dynamic Aspects of Biochemistry. Cambridge University press, London. 554pp.
8. Denniston, K.J., J.J.Topping and R.L.Caret, 2004. General, Organic and Biochemistry, McDraw Hill New York,880 pp.
9. Nelson, D.L andM.M.Cox, 2005. Lehninger Principles of Biochemistry, W.H Freeman,London.1119 pp
10. Forward, R.B.Jr and J.H. Cohen, 2010. Vertical migration of aquatic animals in Encyclopedia of animal behavior,3 Breed M.D. and Moore J. 3eds.), Academic Press, 3:485-490pp.

# SUPPLEMENTARYREADING

* 1. Voet,D.,J.VoetAndC.W.Pratt,2013.PrinciplesOfBiochemistry(1077pp).
  2. GeorgeHadwin.2017.FishEndocrinology(310pp).
  3. F. Melzner1, M. A. Gutowska,M. Langenbuch,S. Dupont, M. Lucassen,M. C. Thorndyke,M. Bleich and H.O. Portner, 2009. Physiological basis for high CO2 toleranceinmarineectothermicanimals:pre-adaptationthroughlifestyleandontogeny? *Biogeosciences*, 6, 2313–2331 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthephysiologyoffeedingandfeedingmechanismofmarineorganisms. |
| CO2: | Tounderstandthephysiologyofbiologicalrhythmsofmarineanimals. |
| CO3: | Tounderstandthephysiologyofnervoussysteminmarinebonyfishesand  elasmobranchs. |
| CO4: | Tounderstandthebioactivemoleculesanditsimportancefrommarineorganisms. |
| CO5: | Tounderstandthemetabolismsofcarbohydrates,aminoacidsandnucleicacidsynthesis. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** |  |  |  | **3** | **3** |  | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** |  | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** |  |  |  | **3** | **3** |  | **3** |
| **CO4** |  | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **09** | **12** | **09** | **09** | **15** | **12** | **09** |

**Semester-II PHYSICALOCEANOGRAPHY**

**Credits:3**

**Hours:3**

**LearningObjective(LO):**

**LO1:**TolearnthehistoryofOceanography,originofOceansandbottomtopography.

**LO2:**Tolearnaboutheatbudgetoftheoceans,sealevelriseandglobalwarming.

**LO3:**Tolearnaboutcurrents,wavesandtidesintheocean.

**LO4:** To learn about the origin and classification of estuaries, estuarine circulation and lagoons. **LO5:** To learn about the origin and physical properties of sediments, classification, distribution and transport of sediments**.**

## UNITI-IntroductiontoOceanography

History of Oceanography, Origin ofOceans, bottom topography, abyssal hillsand plains, submarine canyons & oceanic trenches,underwater volcanoes.

## UNITII-PhysicalPropertiesofseawater

Temperature, density, pressure, conductivity, surface tension, viscosity and their interrelationship, temperature distribution in the sea, hot water springs, heat budget of theoceans, Sea level rise and global warming, UV radiation, sound and light in the sea, Pressure.

## UNITIII–Dynamicsoftheocean

Currents, forces causing surface and deep currents, trade winds and monsoon, wind driven and thermohaline circulation boundary currents, Langumuir circulation, geotropic currents, turbidity currents & up welling. Arctic &Antarctica circulation.

Waves – formation and properties, breakers and surf - internal and standing waves, catastrophic waves, tsunamis or seismic waves, storm waves or surges.

Tides–tidegeneratingforcesandtheories,typesoftides,tidaleffectsincoastalareas.

UtilizationofWave/tideenergy

## UNITIV-Estuaries

Originandclassificationofestuaries,estuarinecirculation,estuarinezonation,lagoons.

## UNITV-Marinesediments

Origin and physical properties of sediments, classification of marine sediments 3lithogenous, biogenous, hydrogenous and cosmogenous), distribution and transport of sediments, determination of age of sediments.

SatelliteOceanography

Tsunami warning system in India and other countries. ELNINO, ROV, Surfer, Recent research development in Deep sea Research and Institutions involved.

## Practical

1. Determinationofdensityofliquidsusingspecificgravitybottle.
2. Measurementofsalinityofseawaterbyrefractometer
3. Determinationofsalinityofseawaterbyconductivity
4. Determinationofsalinityofseawaterbysalinometer
5. Relationshipbetweensalinityanddensity
6. Relationshipbetweensalinityandviscosity
7. Determinationofsurfacetensionbycapillarymethod
8. Relationshipbetweensalinityandsurfacetension
9. Determinationofviscositybyostwaldviscometer
10. Determinationofturbidityusingturbiditymeter,
11. WatersamplingDevices:
    1. Mayer’sWaterSampler
    2. KnudsenWatersampler
    3. NansenWatersampler
    4. UniversalWatersampler
    5. HorizontalWatersampler
    6. BacteriologicalWatersampler
12. SedimentsamplingDevices
    1. Ekman’sDredge
    2. Petersengrab
    3. Mudsnapper
    4. VerticalGravityCorer
    5. OozeSucker
13. Temperatureanddepthmeasuringdevices
14. TowingSurfaceThermometer
15. Six’sMaximumandMinimumThermometer
16. ReversingThermometer
17. Bathythermograph
18. Fortin’sBarometer
19. Lightmeasuringdevices
    1. Secchi Disc
    2. LuxMeter
20. Currentmeasuringdevices
    1. Watt’sCurrentMeter
    2. DirectReadingCurrentMeter
21. Depthmeasuringdevices
22. WaveandTiderecorder

# TEXTBOOKS

1. Sverdrup, H.U., M.W. Johnson and R.H. Flemming 1958. The Oceans – their Physics,Chemistry and General Biology. Prentice – Hall Inc. New Jersey, 1087 pp.
2. McCormick,J.M.andJ.V.Thiruvathakal,1976. ElementsofOceanography.2ndedition,

W.B.Saunders,Philadelphia,346pp.

1. Neshyba,S.1987.Oceanography:perspectiveson a fluidearth.JohnWiley&Sons,New York, 506 pp.
2. Gross, G. 1993. Oceanography: A view of the earth 3sixth edition). Prentice – Hall Inc., New Jersey, 446 pp.
3. Pickard,G.L.andW.J.Emery,1995.DescriptivePhysicalOceanography–anIntroduction (fifth edition). Pergamon Press, London, 520 pp.
4. Stowe,K.,1996.ExploringOceanScience.JohnWileySonsInc,NewYork426pp.
5. Duxbury,A.C.,A.B.DuxburyandK.A.Sverdrup,2000.AnIntroductionToThe World’s Oceans. Wm. C. Brown Publishers,UK. 528 pp.
6. HaroldV.Thurman,2004.IntroductoryOceanography.10thedition,PrenticeHallInc, New Jersey, 624 pp.
7. GennyAnderson,2009.ToolsoftheOceanography:Samplingequipments,measuring equipment, online marine science; Santa Barbara, California, USA.

# SUPPLEMENTARYREADINGS:

1. Heike K. Lotze, Hunter S. Lenihan, Bruce J. Bourque,Roger H. Bradbury, Richard G. Cooke,Matthew C. Kay, Susan M. Kidwell, Michael X. Kirby, Charles H. Peterson, Jeremy B. C. Jackson, 2006.Depletion, Degradation, and Recovery Potential of Estuaries and Coastal Seas. *Science.*1806-1809 pp.
2. Cara Wilson, Victoria J. Coles, 2005. Global climatological relationships between satellite biological and physical observations and upper ocean properties. Journal of Geophysical Research.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | TounderstandthehistoryofOceanography,originofOceans. |
| CO2: | Tounderstandtheheatbudgetoftheoceans,sealevelriseandglobalwarming. |
| CO3: | Tounderstandtheseawatercurrents,wavesandtides. |
| CO4: | Tounderstandtheoriginandclassificationofestuariesandlagoons. |
| CO5: | Tounderstandtheoriginandphysicalpropertiesofsediments. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** |  |  |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** |  |  |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **12** | **12** | **09** | **09** | **15** | **15** | **09** |

**Semester-II CHEMICALOCEANOGRAPHY**

**LearningObjective(LO):**

**Credits:3**

**Hours:3**

**LO1:**Tolearnabouttheoriginofoceansalts,physicalandchemicalpropertiesofwater.

**LO2:**Tolearntheconceptofchlorinityandsalinityofseawater.

**LO3:** To understand the origin, importance and distribution of dissolved gases- Carbon dioxide, oxygen, nitrogen.

**LO4:**Tolearnaboutthedissolvedandparticulateorganicmatter,sourcesandcomposition.

**LO5:**Tolearnabouttheinorganicplantnutrients,originandroleinthefertilityofthesea.

## UNIT1-Introductiontomarinechemistry

Ocean as a chemical system, origin of ocean salts, physical and chemical properties of water, structure of water molecules, differences between freshwater and seawater.

## UNIT2-Chemicalcompositionofseawater

Ionic composition of seawater, major and minor constituents, constancy of ionic composition and factors affecting constancy, major and minor elements, trace elements, their importance and distribution, analytical chemistry of seawater constituents.

Conceptofchlorinityandsalinityofseawater–methodsofmeasurement–desalination.

Marinecorrosion.

## UNIT3-Dissolvedgases

Origin, importance and distribution -Carbon dioxide, oxygen, nitrogen, hydrogen sulphide, noble gases andmethane.

## UNIT4-Organicmatter

Dissolved and particulate, sources, classification, composition, estimation, distribution and seasonal variation, ecological significance, growth promoting and growth inhibiting effects &humic substances.

## UNIT5-Nutrients

Inorganicplantnutrients,origin,roleinthefertilityofthesea.

Kindsof nitrogen,phosphorusandsilicate inthe sea,analytical methods,distributionand cycling, N:P ratio and significance.

Mineralwealthofthesea–salts,glauconite,petroleum,phosphorite,manganesenodules, potential and economics of extraction.

## Practical

**TitrimetricProcedures**

* 1. Salinity
  2. Alkalinity
  3. Dissolvedoxygen
  4. CalciumandMagnesium

## ColorimetricProceduresofpollutants

* 1. Bromide,fluorideandiodide
  2. Nitrite
  3. Nitrate
  4. Inorganicphosphate
  5. HydrogenSulphide
  6. Ammonia
  7. Organicnitrogen
  8. Silicate3Reactive)
  9. Totaldissolvedphosphorus

# TEXTBOOKS

1. Riley,J.P.andR.Chester,1971.IntroductiontoMarineChemistry.AcademicPress, London, 465 pp.
2. Strickland, J.D.H. and T.R. Parsons, 1972. A Practical Handbook of Seawater Analysis. Fisheries Board of Canada, Ottawa, Bulletin, 167:311pp.
3. Riley,J.PandG.Skirrow,1975–1984.Chemical Oceanography,Vols.1to8.Academic Press, London, 606 pp.
4. Blackburn,T.HandJ.Sorensen(Eds.),1988.NitrogenCyclinginCoastalMarineEnvironments, John Wiley & Sons. New York, 338pp.
5. Fergusson,J.E.,1990.TheHeavyElements:Chemistry,EnvironmentalImpactandHealth Effects. Pergamon Press,London 612 pp.
6. Pilson, M.E.Q., 1990. An Introduction to the Chemistry of the Sea. Prentice Hall, NewJersey, 680 pp.
7. Baretta – Bekker, J.G., E.K. Duursma and B.R. Kuipers (Eds.), 1992. Encyclopedia ofMarine Sciences. Springer - Verlag. Berlin Heidelberg, New York, London, 311 pp.
8. Fernando,OliviaJ,1999.SeaWaterPropertiesandDynamics,DhaneshPublications, Thanjavur.
9. Ghosh,A.K.andR.Mukhopadhyay,1999.MineralWealthoftheOcean. Oxfordand IBH Publishing Co, New Delhi 255 pp.
10. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction to the World’s Oceans. 6th Edition. McGraw Hill Companies Inc,NY, 528 pp.

# SUPPLEMENTARYREADINGS:

* 1. K.Friis,A.Kortzinger,andD.W.R.Wallace,2003.Thesalinitynormalizationof marine inorganic carbon chemistry data*. Geophysical Research Letters.*
  2. PaulaG.Coble,2007.MarineOpticalBiogeochemistry:TheChemistryofOceanColor.

*Chem.Rev.*402–418pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandtheoriginofoceansalts,physicalandchemicalpropertiesofwater. |
| CO2: | Tounderstandtheconceptofchlorinityandsalinityofseawater. |
| CO3: | Tounderstandtheorigin,importanceanddistributionofdissolvedgases. |
| CO4: | Tounderstandthedissolvedandparticulateorganicmatter. |
| CO5: | Tounderstandtheinorganicplantnutrients. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  |  |  | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **15** | **09** | **09** | **15** | **15** | **09** |

**Semester-II BIOLOGICALOCEANOGRAPHY**

**LearningObjective(LO):**

**LO1:**Tolearntheseaasabiologicalenvironment.

## Credits:3

**Hours:3**

**LO2:**Tolearnthemethodsofcollectionofphytoplanktonandzooplankton,estimationof standing crop.

**LO3:**Tolearnabouttheprimaryandsecondaryproductionsandmethodsofestimationof primary production.

**LO4:**Tolearnaboutseaweeds–occurrenceanddistribution inIndia;Seagrasses- morphological and anatomical adaptations, their ecological role.

**LO5:** To learn about mangroves, salt marshes and sand dunes- distribution, types, adaptationsand ecological role.

## UNIT1–MarineBiocycle

Seaas a biologicalenvironmentPlankton-classificationof plankton basedonsize, modeof life and habitat.

## UNIT2–Plankton

Phytoplankton and zooplankton - methods of collection, estimation of standing crop, Numerical methods, wet and dry weight estimations, plankton volume, settlement and displacement methods, determination of plankton biomass, oxidation as carbon (as organic matter). Inter relationships and vertical migration.

Adaptationsofplanktonthroughstructural(Weight,increaseofsurface area for flotation) and physiological (specific gravity, water content, fat content, mono and divalent ions, and gas vacuoles) mechanisms.

## UNIT3-Organicproduction

Primaryand secondaryproductions, methodsofestimationofprimaryproduction, factors affecting primary production, spatial and temporaldifferences in primary and secondary productions, red tide phenomenon its causes and effects.

## UNIT4–SeaweedsandSeagrasses

Seaweeds – occurrence and distribution in India, their economic importance. Interaction between reefs and seaweeds.

Seagrasses–morphologicalandanatomicaladaptations,theirecologicalrole.

## UNIT5–Mangroves,saltmarshesandsanddunes

Distribution, types, adaptations (morphological, anatomical and physiological),ecological role, uses, need for conservation.

## Practical

1. Identification of phytoplankton and zooplankton (diatoms, dinoflagellates, hydromedusae, copepods, pteropods, Chaetognatha, Thaliaceae and larvae of fin and shell fishes).
2. Identification of locally available seaweeds, seagrasses, sand dune spp. andhalophytes including mangrove plants / vegetation 3herbs, shrubs and woody plants)
3. Primary productivity studies – light and dark bottle method, extraction and identification of plant pigments (chlorophylls)including phaeopigments from water samples of estuary, sea and mangroves (Acetone method)
4. Fieldcollection–submissionofherbariumsheets.

# TEXTBOOKS

1. Wimpenny,R.S.,1966.PlanktonoftheSea.FeberandFeberLimited,London,426pp.
2. Raymont,J.E.G.,1973.PlanktonandProductivityintheOceans.OxfordPergamon Press, London, 660pp.
3. Chapman,V.J.,1976.MangroveVegetation.J.Gramer,Berlin,292pp.
4. Chapman,V.J.andD.J.Chapman,1980.SeaweedsandTheirUses.Chapman&Hall London Ltd.334pp.
5. Spoel S. Vander and R.P. Heyman, 1983. Comparative Atlas of Zooplankton Biological Patterns in the Oceans. Springer - Verlag, Berlin, 186 pp.
6. Tomilson, P.B., 1986. The Botany of Mangroves. Cambridge University Press.London,413pp.
7. Nybakken,J.W.,2001.MarineBiology–AnEcologicalApproach..Addisonwesley Edu. Pub. Inc,London,516 pp.
8. Kinne,O.,2004.MarineEcology:Comprehensiveintegrated treatiseonlifein oceans and coastal waters, Wiley-interscience, New York Volume 1 -5 (1970 – 1984).
9. Miller,C.B.2004.BiologicalOceanographyWiley-BlackwellUS402pp.
10. Kathiresan, K and S.Z. Qasim, 2005. Biodiversity of Mangrove Ecosystems. Hindustan Lever Limited, India,251 pp.
11. JeffreyS.Levinton,2008.MarineBiology: Function,Biodiversity,Ecology,3rded.oxford university press ,USA 640pp.

# SUPPLEMENTARYREADINGS:

* 1. Hurd,C.L.,EtAl.,2014.SeaweedEcologyAndPhysiology(551pp).
  2. William M. Sackett,Walter R. Eckelmann,Michael L. Bender,Allan W. H. Be, 1965. Temperature Dependence of Carbon Isotope Composition in Marine Plankton and Sediments. *Science*. 235-237 pp.
  3. Shing Yip Lee, Jurgene H. Primavera, Farid Dahdouh‐Guebas, Karen McKee, Jared O.Bosire, Stefano Cannicci, Karen Diele, Francois Fromard, Nico Koedam, CyrilMarchand,IrvingMendelssohn,NibeditaMukherjeeandSydneRecord,2014.Ecological role and services of tropical mangrove ecosystems: a reassessment. *A Journal of Macroecology*. 726-743 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthebiologicalenvironmentofsea. |
| CO2: | Tounderstandthecollectionmethodsofphytoplanktonandzooplankton. |
| CO3: | Tounderstandtheprimaryandsecondaryproductionsanditsinvolvements. |
| CO4: | Tounderstandthedistributionandoccurrenceofseaweedsandseagrass. |
| CO5: | Tounderstandthemangroves,saltmarshesandsanddunes. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** |  |  |  | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** |  | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **12** | **15** | **09** | **09** | **15** | **15** | **09** |

**Semester-II COASTALAQUACULTURE**

**LearningObjective(LO):**

**Credits:3**

**Hours:3**

**LO1:** To know theimportance of coastal aquaculture, global scenario andits present status inIndia.

**LO2:** To learn about selection of site: topography, water availability and supply, soil conditions. **LO3:**Toleanthecriteriaforchoosingcultivablespecies-fish,crustaceans,mollusksandseaweeds.

**LO4:**Tolearnaboutthenaturalseedresources-distribution,abundanceandmethodsof collection and segregation.

**LO5:**Tolearnabouttheculturepractices-traditional,extensive,semiintensive,intensive system, monoculture and polyculture.

## UNITI-Introductiontocoastalaquaculture

Overview–ImportanceofCoastalaquaculture,globalscenario,presentstatusinIndia- prospects and scope.

## UNITII-Brackishwaterfarms

Selection of site: topography, water availability and supply, soil conditions. Designing and layout, farm structure and construction.

## UNITIII-Biologyofimportantcultivablespecies

Criteria for choosing cultivable species – fish, crustaceans, molluscs and seaweeds - biological criteria - environmental adaptability - compatibility of species - adaptability to intensive culture - economic criteria - market value - availability in adjacent regions.

## UNITIV–SeedresourcesurveyandSeed&Feedproduction

Natural seed resources – distribution and abundance, methods of collection and segregation. Artificial seed production - breeding under controlled condition, techniques of induced breeding, larval rearing, packing and transportation.

Larval and adult feeds. - Live feed – Micro algae, rotifers, copepods and artemia. Formulationoffeed–conventionalandnon-conventionalingredients,additives,feedattractants, formulation protocol.

## UNITV–Culturesystemsandtheirmanagement

Culturepractices–traditional,extensive,semi–intensiveandintensivesystems, monoculture and polyculture, raceways, cages,pens, raft and racks.

Culturesystemmanagement:Pondpreparation–productionandeconomics.

Waterqualitymanagement,Healthmanagement:Controlofpredators,parasitesand diseases.

. Diseasediagnosis:Concepts-ELISA,Westernblotting:DNAbaseddiagnosisof diseases – fish vaccines.

## Practical

1. Field trip to coastal aquaculture farms, hatcheries, raceways and Rack & Raftand procuring plants and Submission of Report
2. Spatcollectiontechniques
3. Dissectionofreproductivesystemsoffishandshrimp.
4. Identificationofeggs,larvae,seeds,andjuvenilesofcultivablespecies.
5. Seedcollectiontechniques–velonscreen,Thrownet,otherscoopnets
6. Inducedbreedingandmaturationtechniquesinfishes.
7. Identificationofcultivablespeciesofcrustanceans,molluscs,finfishesandseaweeds.
8. Identificationoflivefeed(Microalgae,rotifers,copepodsand*Artemia*).
9. Westernblotting
10. PCRDemonstration
11. Typesofdiseases–Observation
12. Identificationofdifferentlarvalstagesinshrimps
13. FabricationofRack&Raft(floatingandfixed),ropecultureandspatcollectors(rens).

# TEXTBOOKS

* 1. Pillay,T.V.R.,1990.Aquaculture–PrinciplesandPractices.FishingNewsBooks.575pp.
  2. SamuelPaulraj,1994.ShrimpFarmingTechniques:ProblemsandSolutions.Palanipub.
  3. Stickney,1995.IntroductiontoAquaculture.JohnWiley&Sons,NewYork.
  4. Coche, G. and J.F. Muir, 1996. Simple Methods for Aquaculture Pond Construction for Freshwater Fish Culture : Pond farm structures and layouts. Daya Pub, 214 pp.
  5. Conroy, D.A. andR. L. Herman, 1997. Text Book of Fish Disease. Narendra Pub, 302 pp.
  6. JohnE.Bardach,1997.SustainableAquaculture.JohnWiley&Sons,NewYork.
  7. James,W.Meade,1998.AquacultureManagement,CBSpub.,NewDelhi.
  8. RobertR.Stickney(ed.),2000.EncyclopediaofAquaculture.JohnWileyandSons,Inc., New York.
  9. Joachim W. Hertrampft and Felicitas Piedad – Pascal, 2000. Hand Book on Ingredients for Aquaculture Feeds. Kluwer Academic Publishers, London.
  10. Velayutham,T.S.,Kripa,V.andH.Nithin,2007. MaricultureofMusselsinIndia. Manual of CMFRI, Cochin.

# SUPPLEMENTARYREADINGS:

1. LingarajPatro,2015.FisheriesAndAquaculture(473pp).
2. George,N.AndN.S.Charan,2016.FishFarming(243pp).
3. JHPrimavera,2008.Socio‐economicimpactsofshrimpculture.AquacultureResearch. 815-827 pp.
4. Xie Biao and YuKaijin, 2007. Shrimp farming in China: Operating characteristics, environmentalimpactandperspectives.OceanandCoastalmanagement.538-550pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandtheimportanceofcoastalaquaculture. |
| CO2: | Tounderstandthesiteselectionsandsoilconditions. |
| CO3: | Tounderstandthecultivablefinandshellfishes. |
| CO4: | Tounderstandthenaturalseedresourcesandavailability. |
| CO5: | Tounderstandthevariousculturepractices. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** |  |  |  | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** |  |  | **3** | **3** | **3** | **3** | **3** |
| **Total** | **12** | **12** | **09** | **09** | **15** | **15** | **09** |

**Semester-II FISHERIESSCIENCEANDSTATISTICS**

**LearningObjective(LO):**

**Credits:4**

**Hours:4**

**LO1:**Tolearnaboutthegeneralmorphologyandoutlineclassificationoffishesandidentification of fishes of Parangipettai.

**LO2:** To learn about the fundamental principles of population dynamics, unit sock, recruitment, growth, mortality and fish tagging.

**LO3:** To study about the marine fisheries of India, methods of surveying the fishery resources- acoustic and aerial method.

**LO4:** To learn the principle methods of exploitation of sea fishes- indigenous and modern gears and crafts.

**LO5:**Tolearnaboutsamplingtechniques- biometryoffish-collection andanalysisofbiological data.

## UNITI–Ecobiologyoffishes

General morphologyandoutlineofclassificationof fishes– majorgroupsof fishesofthe world and their characteristics, identification of fishes of Parangipettai.

Basic anatomy of fish – digestive, circulatory, respiratory, nervous and reproductive systems of fish. Maturation and spawning habits of marine fishes – process of maturation, methodstodeterminespawning, bioticandabioticfactorsaffectingspawning infishes.Foodand feeding, fecundity and GSI

## UNITII-Populationdynamics

Fundamental principles of population dynamics, unit stock, recruitment, growth, mortality, migration, fish tagging and marking. Ecosystem Based Management of Marine fisheries.

## UNITIII–MethodsofFisherySurvey

Marine fisheries of India, methods of surveying the fishery resources– acoustic method, aerial method (Remote Sensing – PFZ) -survey of fish eggs and larvae, gear selectivity, trawl net and Gill net, mesh size selection

## UNITIV–CraftsandGears

Principal methods ofexploitation ofsea fishes– indigenousand modern gears andcrafts. Principal methods of fish preservation and processing in India– types of fish spoilage, causative factors. Marketing and economics.

## UNITV–Statisticsinfisheries

Sampling techniques – Biometry of fish - Collection and analysis of biological data – mean, median, mode, standard deviation, standard error, coefficient of variation, student ‘t’ test, skewness, kurtosis, chi – square, correlation regression and analysis of variance. Fisheries Statistic Software (ECOPATH, PRIMER, FISH STAT)

## Practical

1. IdentificationofcommonfinandshellfishesofParangipettaiwaters.
2. Dissectionof9thand10thcranialnervesofteleostfishes
3. FoodandfeedinghabitsoffishesthroughGutcontentanalysisandDigestivesystemin fishes, Structure of gill filament and gill rakers.
4. Study of food and feeding habits of fishes using gut-content analysis, Dissection and display of digestive system of fishes of different feeding habits.
5. Studyofreproductivesystemofteleostfishes
6. Fecundityestimationandova–diameterstudies,GSIvalues
7. Lifehistorystagesoffishes:eggsandlarvae.
8. Morphometricandmeristicdataoffishespopulation
9. Collectionofcostofdifferentfishes(primaryandsecondary)andpatternofmarketing
10. Economicsoffishingoftrawler.
11. Growthdeterminationusingscales:vertebrates&otoliths
12. Morphometricandmeristiccharactersofateleostfish
13. Dissectionanddisplayofinnerearinafish,Weberianapparatusinacat fish
14. Dissectionanddisplayofswimbladderoffishes
15. Observationonfishparasites
16. VisitstoicefactoryandnearbyfishprocessingUnits.
17. MethodsofsamplingandDatacollection
18. CalculationofMean,Mode,StandardDeviation,StandardError,Co-efficient,Variation
19. Calculationofcorrelationofco-efficiency&ANNOVA

# TEXTBOOKS

1. Lagler, K.F., J.E. Bardach and R.R. Miller, 1962. Icthyology. John Wiley & Sons Inc.,New York, 545 pp.
2. Bal, D.V. and K.V. Rao, 1990. Marine Fisheries of India. Tata McGraw Hill Publishing Company Limited, New York, 472 pp.
3. Shanmugam,K.,1990.FisheryBiologyandAquaculture.LeoPathippagam,Madras, India.698pp.
4. King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Books, Black well science Ltd., 341 pp.
5. Biswas,K.P.,1996.A TextBookofFish,FisheriesandTechnology,IIED.Narendra Publishing House, Delhi, India, 396 pp.
6. Srivastava , C.B.L., 1999. Fish Biology. Narendra Publishing House, Delhi (India), 304 pp.
7. MohanJoseph,MandA.A.Jayaprakash,2003.StatusofExploitedMarinefishery resources of India, 308 pp.
8. Dholakia, A.D., 2004. Fisheries and Aquatic resources of India. Daya Publishing House, Delhi.413 pp.
9. Nelson, J.S, 2006. Fishes of the World, 4th edition, John Wiley & Sons, Inc., Hobaken,New Jersy, USA, 601 pp.
10. Bore, Q and Richard H. Moore, 2008. Biology of fishes, 3rd edition, Taylor and Francis Groups, New York, 478 pp.

# SUPPLEMENTARYREADINGS:

* 1. Singh,R.K.,2013.FisheryResources(256pp).
  2. Giriappa,S.,2015.RoleOfFisheriesInRuralDevelopment(178pp).
  3. RayHilborn,2011.DeterminationofFishMovementPatterns fromTagRecoveriesusing Maximum Likelihood Estimators. *Canadian Journal of Fisheries and Aquatic Sciences*. 635-643 pp.
  4. PierrePetitgas,AdriaanD.Rijnsdorp,MarkDickey‐Collas,GeorgH.Engelhard,Myron

A.Peck,JohnK.Pinnegar,KenDrinkwater,MartinHuretandRichardD.M.Nash, 2012. Impacts of climate change on the complex life cycles of fish.*Fisheries Oceanography*. 121-139 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthemorphologyandoutlineclassificationoffishes. |
| CO2: | Tounderstandthefundamentalprinciplesofpopulationdynamics. |
| CO3: | TounderstandthemarinefisheriesofIndiaandtheirsurveymethods. |
| CO4: | Tounderstandtheexploitationmethodsofmarinefishes |
| CO5: | Tounderstandthesamplingtechniquesandbiometryofmarinefishes. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  |  |  | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** |  |  |  | **3** | **3** |
| **Total** | **15** | **15** | **06** | **06** | **12** | **15** | **09** |

**Semester-III MARINEECOLOGYANDZOOGEOGRAPHY**

**LearningObjective(LO):**

**Credits:4**

**Hours:4**

**LO1:**Tostudyaboutmarineenvironment,ecologicalfactors-light,temperature,salinity,pressure. Marine zoogeography.

**LO2:** To learn the concept of ecosystem structure and function, functional attributes food chain and food web.

**LO3:**Tolearnaboutgroupattributes,populationdensityvariation,agestructuresexratio population growth.

**LO4:**Tolearnaboutthestructurecompositionandstratification,diversityandstabilityand concept of niche.

**LO5:**Toknowtheimportanceofbiodiversity,assessmenttechniquesandthreatstomarine biodiversity.

## UNIT1–ClassificationofMarineEnvironment

Marine environment – ecological factors – light, temperature, salinity, pressure. Classification of marine environment – pelagic environment, planktonic and nektonic adaptations, benthicenvironment– intertidal, interstitial anddeep– seaadaptation.Othercoastal environments – coral reefs, estuaries, mangroves, seagrass beds, kelp forests, polar seas and hydrothermal vent. Marine zoogeography. Barriers, Centre of dispersal, Bipolarity, Endemism, Island fauna.

## UNIT2-Marineecosystem

Concept- ecosystem structure and function,functional attributes food chain, food – web, ecological pyramid,energy flow. recycling of nutrients.

Systems ecology and modeling- System structure, feed-back, loops and types of models, characteristics and behavior of a system. Ecosystem services.

## UNIT3-Populationecology

Group attributes, population density variation, age strucutre sex ratio population growth, carrying capacity, dispersal, density dependent and independent factors. prey – predator relationship, Intraspecific & Interspecific competition, survivorship curve, r/k selection,

## UNIT4-Communityecology

Structure composition and stratification, diversity and stability, concept of niche, edge effect – abundance of diversity, resilence, succession, community-wise adaptation (e.g. fouling and boring community, animal association in the sea).

## UNIT5-Marinebiodiversity

Definitionandimportance,biodiversityassessmenttechniques,threatstomarine biodiversity, over-exploitation, physical alteration, pollution, alien species. Biosecurity.

## Practical

1. Populationanalysisof*Cerithideacingulata,Ucasp.:*QuardrateandTransectmethod
2. Sexratioof*Uca*sp.
3. Collectionandidentificationofanimalandcommunitystudiesofdifferentenvironments
   1. Pelagic
   2. Muddyshore
   3. Sandyshore
   4. Rockyshore
   5. Interstitial
   6. Oysterbedcommunity
   7. Phytalfaunalcommunity(Seaweedandseagrass).
   8. Foulingandboringorganisms
   9. Assessmentofbiodiversityofanyoneoftheabovecommunities
4. PreparationofaFieldReport.

# TEXTBOOKS

1. Briggs,J.C.,1974.MarineZoogeography.McGrawHill,NewYork,475pp.
2. Nair, N.B.and D.M. Thampy, 1980.A TextBook ofMarine Ecology. The Macmillan Co. India Ltd., New Delhi, 352 pp.
3. Odum,E.P.1987.BasicEcology.SaundersCollegePublication,Philadelphia,895pp.
4. Heywood, V.H. and R.T. Watson (Eds.), 1995. Global Biodiversity Assessment. UNEP Cambridge University Press.765pp.
5. Hawksworth, D.L. 1996. Biodiversity Measurement and Estimation. Chapman Hall, 140 pp.
6. Ormond,F.G.R., J.D. Cage and M.V.Angel (Eds.) 1997. Marine Biodiversity: Patternsand Processes. Cambridge university press, London 449 pp.
7. Barnes,R.S.K.andR.N.Hughes.1999.AnIntroductiontoMarineEcology(Third edition), Blackwell Science, US.286 pp.
8. TownsendC.R.,J.L.HarperandM.Begon.2000.EssentialsofEcology.Blackwell Science, US. 552 pp.
9. Nybakken,J.W.2001.MarineBiology–Anecologicalapproach(Fourthedition) Addison Wesley Edu. Pub. Inc,US. 516 pp.
10. Jeffrey S. Levinton, 2008. Marine Biology:Function, Biodiversity, ecology, 3rd edition Oxford University press US. 640 pp.

# SUPPLEMENTARYREADINGS:

1. HajimeKayanne,2016.CoralReefScience(101pp).
2. Salvanes,A.G.V.,etal.,2018.MarineEcologicalFieldMethods(218pp).
3. JohnS.Gray(1997).Marinebiodiversity:patterns,threatsandconservationneeds. Biodiversity and Conservation 6, 153-175.
4. John J.Stachowicz,RobertB.Whitlatchand RichardW.Osman,1999.SpeciesDiversity and Invasion Resistance in a Marine Ecosystem. *Science.* 1577-1579 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto:

|  |  |
| --- | --- |
| CO1: | Tounderstandthemarineenvironmentandecologicalfactors |
| CO2: | Tounderstandthecoastalecosystemstructureandfunction. |
| CO3: | Tounderstandthegroupattributes,populationdensityvariation. |
| CO4: | Tounderstandthestructurecompositionandstratification. |
| CO5: | Tounderstandtheimportanceofbiodiversityanditsassessment. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** |  |  |
| **CO5** | **3** | **3** | **3** | **3** |  |  |  |  | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** |  |  |
| **CO5** |  |  |  | **3** | **3** | **3** | **3** |
| **Total** | **12** | **12** | **06** | **09** | **15** | **12** | **06** |

**Semester-III MARINEBIOTECHNOLOGY,BIOINFORMATICS**

# ANDINSTRUMENTATION

## LearningObjective(LO):

**Credits:4 Hours:4**

**LO1:**Tolearnaboutthetoolsandtechniques:PCR,blotting,GeneprobesandGenesequencing. **LO2:** To study about the bioactive compounds from marine environment:isolation, purification and identification of compounds.

**LO3:**Tolearnaboutrecombinantproteinproductioninmicrobes.

**LO4:**TostudyaboutthehistoryofBioinformatics,Databasesearching(BLAST).

**LO5:**TolearnaboutChromatographyandSpectroscopy.

## UNIT1–ToolsandTechniques

Introduction to marine biotechnology & genetic engineering - Tools & Techniques: PCR, blotting, Gene probes, gene sequencing : RAPD, RFLP & ELISA - Electrophoresis – Paper, agarose, PAGE, PFGE & Iso – Electric Focusing.

## UNIT2-MarinePharmacology

Prospects – Bioactive compounds from marine environment: isolation, purification and identification of compounds.

## UNIT3–MarineMicrobialTechnology

Recombinant protein production in microbes; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts(Streptomyces/Yeast)

## UNIT4-Bioinformatics

Definitionandhistory

Internet basics: Internet connection, Web browsing and URL; Data bases – Nucleic acid sequence databases (NCBI, EMBL, DDJB), protein sequence database (SWISS – PROT).

Database searching (BLAST); protein prediction – structure and functionprediction of proteins.

Molecular visualization and tools for molecular visualization (RASMOL and MOLMOL).

## UNIT5–Chromatography&Spectroscopy

Chromatography:Principlesofpaper,thin layer,ion-exchange,affinity, gas-liquid chromatography and HPLC.

Spectroscopy:Absorptionandemissionprinciples,UV-vis,Atomicabsorptionandemission spectrophotometers, fluorescence spectrophotometer, NMR and Mass spectrometer.

## Practical

1. ExtractionandquantificationofNucleicacidandproteins
2. Electrophoresis–AgarosegelelectrophoresisandPAGE.
3. Blotting(Southern&Western)&PCR
4. Tissueculturetechniques-Preparationandmaintenanceofplantandanimalcelllines
5. Chromatography
   1. Paper
   2. Column
   3. TLC
6. BasicprinciplesandapplicationofatomicabsorptionSpectrophotometer,Inductivelycoupled plasma spectrophotometer, GC, FT-IR, GC-MS, HPLC, UV-Visible spectrophotometer and fluorescence spectrophotometer
7. BLASTsearchforsimilarnucleotidesequences
8. Proteinsecondarystructure,tertiarystructureandMotifsprediction.
9. Visualizing3DstructureofmacromoleculesusingRASMOL.
10. Isolationandextractionofbioactivecompoundsfrommarineorganisms

# TEXTBOOKS

1. AlanT.Bull,GeoffrerHoltandMalcolmD.Lilly,1983.BiotechnologyInternational Trends and Perspectives. Oxford & IBH Publishing Co., New York, 84 pp.
2. Ewing,G.W.,1988.Instrumentalmethodsofchemicalanalysis,McGraw-HillBook Company, NY.538 pp.
3. Skoog, D.A. and J.J. Leary, 1992. Principles of instrument analysis. 4thedition. Saunders College publishers, Philadelphia, 700 pp.
4. DavidH.AttawayandR.Oskar,1993.MarineBiotechnology.Vol.I.Pharmaceutical and Bioactive Natural Products. Plenum Press, New York & London, 500 pp.
5. Pat Vaughan, 2000. Methods in Molecular Biology: DNA Repair protocols: Prokaryotic Systems , Human press, Totowa, New Jersey. P. 209.
6. Baxevanis, A.D. and B.F. Francis Quellette, 2002.Bioinformatics: Practical Guide to the analysis of genes and proteins, John Wiley and Sons, NY 470 pp.

# SUPPLEMENTARYREADINGS:

* 1. Brown,T.A.,2016.GeneCloningAndDnaAnalysis:AnIntroduction(353pp).
  2. Sabamurthy, K. And Ashutosh Kar, 2016. Pharmaceutical Biotechnology: Fundamental and Applications (497 pp).
  3. Patricia Rodriguez Tome, Peter J. Stoehr, Graham N. Cameronand Tomas P. Flores, 1996. The European Bioinformatics Institute (EBI) databases. *Nucleic Acids Research.* 6–12 pp.
  4. Anand, N., Rachel, D., Thangaraju, N., and Anantharaman, P., 2016. Potential of marine algae (seaweeds) as source of medicinally important compounds*. Plant Genetic Resources,* 14(4), 303-313 pp. doi: 10.1017/S1479262116000381.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthebiotechnologicaltoolsandtechniques. |
| CO2: | Tounderstandthebioactivecompoundsfrommarineorganisms. |
| CO3: | Tounderstandtherecombinantproteinproduction. |
| CO4: | Tounderstandtheconceptofbioinformaticsanditsapplications. |
| CO5: | Tounderstandtheimportanceofchromatographyandspectroscopy. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** |  |  |  |
| **CO5** | **3** | **3** | **3** |  |  | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** |  |  |  |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **15** | **09** | **09** | **12** | **12** | **06** |

**Semester-III POLLUTIONANDTOXICOLOGY**

**LearningObjective(LO):**

## Credits:4

**Hours:4**

**LO1:** To study about marine pollution, GESAMP, major pollutants- source and transport path. **LO2:** To studyabout sewage, industrial,agricultural and domestic discharge and composition of sewage.

**LO3:** To study about heavy metal pollution- sources, distribution and fate **LO4:**Tostudyaboutoilpollution-composition,sourcesandfateofspilledoil. **LO5:** To study about thermal pollution- sources and waste heat disposal.

## UNIT1-BasicsinMarinePollution

Marine Pollution – Definition of GESAMP - Major pollutants – sources, transportpath, dynamics. monitoring methods, bioindicators,bioaccumulators and hot spots

Toxicology – Lethal and Sub-lethal effects of pollutants to marine organisms bioconcentration, bioaccumulation and biomagnification, methods of toxicity testing, factors influencing toxicity, synergistic and antagonistic effects, role of microcosms & mesocosms.

## UNIT2-MajorPollutants–SewageandDetergent

Sewage; industrial,agriculturalanddomesticdischarges.CompositionofSewage- impact on marine environment, treatment methods (primary, secondary and tertiary).

Detergents–composition–eutrophicationandecologicalsignificance, interferenceinthe sewage treatment system.

## UNIT3–Majorpollutants–Heavymetals&pesticide

Heavy metal pollution– sources, distribution, fate, toxicity and diseases(Minamata, itai- itai etc.)

Pesticide pollution, classification and composition – sources, transport, distribution, fate and ecological impactsin the marine environment – endocrine disrupters.

## UNIT4–MajorPollutants- Oil

Oil pollution – composition, sources andfate of spilled oil, biodegradation, biologicalimpact of oil on marine organisms.

## Unit5–MinorPollutants

Thermal pollution –sources – wasteheatdisposal, uses of wasteheat,role ofbiocides (Chlorine), ecological impacts.

Radioactive pollution, sources (natural and artificial), distribution,biological effects of radiation.

Plasticsandlitter–impactofmininganddredgingoperationsinthemarineenvironment.

## Practical

Analysisandestimationofcriticalpollutants.

1. EstimationofAmmonia(NH3)
2. EstimationofHydrogensulphide(H2S)
3. EstimationofBOD
4. EstimationofCOD
5. Pesticideresiduesinseawaterandselectedbeeverages
6. Petroleumhydrocarbonsinseawater
7. Heavymetals(Cu,Cd,Pb,Hg)inseawater,sediments&animaltissues
8. Preparationofsolution(Standard,Normal,Molar)fortoxicologicalstudies
9. Methodologyoftoxicitytesting–acuteandchronictests(demonstration)
10. UseofLC50values–sublethaleffectsofcriticalpollutantsonfishandshellfish.

# TEXTBOOKS

1. Johnston,R.(Ed.),1976.MarinePollution.AcademicPress,London,729pp.
2. Pantin, S.A., 1982. Pollutionand the BiologicalResources of the Oceans. ButterworthScientific Co., London.
3. Clark,R.B.,1992.MarinePollution.3rdEdition.ClavendonPress,Oxford,UK172pp.
4. CarlJ.Sindermann,1995.OceanPollution:EffectsonLivingResourcesandHumans 7/176 – CRC Press, Baca Raten Tokyo275pp.
5. Michael J. Kennish., 1996. Estuarine and Marine Pollution.(524 pp.) 07/002 CRC Press, New York.
6. MichaelJ.Kennish,1997.PollutionImpactsonMarineBioticCommunities(310pp)7/77, CRC press, New York.
7. David J.Hoffman, Barnett A. Rattner, G.Allen Burton, Jr.JohanCaims, Jr., 1997. HandBook of Ecotoxicology (755pp) – 7/018. Lewis publishers, Tokyo.
8. Trivedi,R.K.2001.AquaticToxicologyandToxicology(239pp)7/157–ABD publishers, Jaipur
9. MichaelC.Newman,MorrisH.Roberts,Jr.RobertC.Hale,2001.CoastalandEstuarine Risk assessment (347pp) 07/125 Lewis publishers, New York
10. YasunoriMurakami,KeiNakayama,shin–Kitamura.,2008.BiologicalResponseto Chemical pollutants. Terra pub, Tokyo, 372 pp.

# SUPPLEMENTARYREADINGS:

1. John F. Piatt, Calvin J. Lensink, William Butler, Marshal Kendziorekand David R. Nysewander, 1990. Immediate Impact of the 'Exxon Valdez' Oil Spill on Marine Birds. *The Auk: Ornithological Advances*. 387–397 pp.
2. ShinsukeTanabeaMaricarSPrudentebSupawatKan-atireklapcAnnamalaiSubramanian, 2000. Mussel watch: marine pollution monitoring of butyltins and organochlorines in coastal waters of Thailand, Philippines and India. *Ocean & Coastal Management*. 819- 839 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthemarinepollutionandpollutants. |
| CO2: | Tounderstandthevariouspollutantsandtheirimpactoncoastalenvironment. |
| CO3: | Tounderstandtheheavymetalpollutionanditsimpact. |
| CO4: | Tounderstandtheoilpollutionsanditsimpact. |
| CO5: | Tounderstandthethermalpollutionanditsimpactonmarineenvironment. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** |  |  | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **15** | **09** | **09** | **15** | **15** | **09** |

**Semester-III OceanManagement**

**LearningObjective(LO):**

## Credits:4 Hours:4

**LO1:** To study aboutthe Law of the sea, the Geneva convention- UNCLOS series and Antarctic treaty.

**LO2:**Tostudybiodiversityfromaglobalandnationalview.

**LO3:**Tostudyabouttheimportanceofcoastalzoneandcoastaldevelopmentalactivitiessuchas mariculture.

**LO4:** To study about coastal zone management issues- major ecological, social and economictrend.

**LO5:**TostudyRSandGISTechnologies-applicationinmarineresourcesexploration.

Unit–I:**Lawofthesea**

Law of the sea – the Geneva convention – UNCLOS series – the Antarctic treaty and its importance – the sea bed treaty – scientific, economic and geo-political aspects of seabed exploration and mining – earth summit (UNCED).

RoleofInternational,NationalAgenciesandOrganizationsinOceanManagement Unit – II: **Biodiversity and Conservation**

Biodiversity from a global and national view – current status of marine biodiversity – biodiversity conservation – endangered marine animals – CITES convention – marine biosphere reserves – marine parks - Marine Protected Areas - Biodiversity Act, 2002 - National – Biodiversity Authority.

Unit–III:**DevelopmentalActivitiesandImpacts**

Coastal zone importance – coastal developmental activities such as mariculture, tourism, shorefront construction and their impacts – global and national coastal problems such as loss of habitat, sea level change, degradation of water quality and fisheries resource depletion.

Unit–IV:**Coastalzonemanagementissues**

Coastal zone management issues– major ecological, social and economic trend and their importance – coastal zone regulations-91, aquaculture authority bill- CZM programs – Integrated Coastal Zone Management – categorization – coastal management zones - CRZ Notification 2011 - Comparison between developed and developing countries, temperate and tropical countries and their CZM.

Unit–V:**Remotesensing& GIS**

RS & GIS Technologies – Application in marine resources exploration, satellites and airborne remote sensing, GIS in marine & Coastal zone management – Mapping & monitoring of pollution, changes in Coastal zone. – Application in disaster management – Tsunami types & causes – Post – Tsunami damage assessment and rehabilitation.

TEXTBOOKS

1. Ross,D.A.,1980.OpportunitiesandUsesoftheOcean.SpringerVerlag,NewYork
2. Roonwal, G.D. (Ed.) 1986.The Indian Ocean, Exploited Mineral and Petroleum Resources, Springer-Verlag, Berlin, 198 pp.
3. Miller, B.T and J.G. Catena, 1991. The Living Ocean Understanding & ProtectingMarine Biodiversity.
4. Sharma, R.C. and P.C. Sinha, 1994.India’s Ocean Policy, Khama Publishers, New Delhi.
5. Glowka, L., Guitman, F.B & H. Syrge, 1994, A. Guide to the Convention on Biological Diversity, IUCN. The World Conservation Union.
6. Rajagopalan,R.(Ed.),1996.Voices fortheOceans–AReporttotheIndependentWorld Commission on the Oceans.International Ocean Institute, Operation Centre, Madras, India.
7. Sabins, F.F., 1996.Remote Sensing Principles and Interpretation.Third edition.W.H. Freeman & Company, New York, 494 pp.
8. Qasim, S.Z. and G.S. Roonwal, 1998.India’s Exclusive Economic Zone.Omega Scientific Publishers, New Delhi.
9. Qasim, S.Z., 1999.The Indian Ocean– Images and Realities.Oxford &IBH Publishing Company, India, 340 pp.
10. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000.AnIntroduction to the World’s Oceans. 6th Edition.McGraw Hill Companies, 528 pp.

# SUPPLEMENTARYREADINGS:

1. Vats,C.K.,2015.CoastalZoneManagement(312pp).
2. Robert G. Healy & Jeffrey A. Zinn, 1985. Environment and Development Conflicts in CoastalZoneManagement,JournaloftheAmericanPlanningAssociation,51:3,299-311 pp.
3. FaridDahdouh-Guebas,2002.TheuseofRemotesensingandGISinthesustainable management of Tropical Coastal Ecosystems. *Environment, Development andSustainability.*93–112 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | TounderstandthelawoftheseaandtheGenevaConvention. |
| CO2: | Toviewthebiodiversityinglobalandnationallevel. |
| CO3: | Tounderstandtheimportanceofcoastalzoneandcoastaldevelopmentalactivities. |
| CO4: | TounderstandtheRSandGISTechnologies. |
| CO5: | TounderstandtheRSandGISTechnologies-applicationinmarineresources  exploration. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  | **3** |
| **CO4** | **3** | **3** | **3** |  |  |  | **3** |  | **3** | **3** |  | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** |  | **3** |
| **CO4** |  | **3** |  | **3** | **3** |  | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **12** | **15** | **09** | **09** | **15** | **09** | **09** |

**Semester-IV OrnamentalFishCulture&AquariumKeeping**

**LearningObjective(LO):**

**Credits:4**

**Hours:4**

**LO1:**Tostudythefreshwaterandmarineaquariumstatus,ornamentalfishtrade,aquarium fishes and collection strategies.

**LO2:**Tounderstandtheculturingpracticesandhatcherytechniquesandlivefeedculture.

**LO3:** To study the designing of fish tanks, aeration, filtration and lighting setup inthe aquarium tanks.

**LO4:**Tostudythesettingofaquariumtanksanddecorationinindoorandoutdooraquarium tanks.

**LO5:**Tostudythepreparationofpelletfeedanddiseasemanagementintheaquariumfishes.

UnitI**Introduction**

Fresh and marine water aquaria - Global and Indian status of aquarium keeping- Ornamental fishtradeAdvantagesandbenefits-Criteriaforchoosingaquariumfishes-Commonaquarium fishes - collection techniques.

UnitII**Cultureandhatcheryproduction**

Breedingoffreshandmarinewaterornamentalfishes-collection-conditioning-broodstock development -feeding - spawning - larval rearing - Live feeds - stock and mass culture.

## UnitIIIDesigning,Aeration,filtrationandlightings

Indoorandoutdooraquaria-Tankdesigns-fabrication-choosingofrighttank-Airpumps- filters biofilters - devices - aquarium lights - water quality maintenance - test kits.

UnitIV**Settingupofaquarium**

Freshandmarinewatersetup-aquascaping-addingdecorative materials-aquariumplants- community aquarium.

UnitV**Healthmanagement**

Basic diets - pellet feeds- formulation- Diseases - diagnosis and health management-treatment methods Colour enhancement - induced breeding

# REFERENCEBOOKS

1. Dawes,J.,1995.LivebearingFishes(AguidetotheirAquariumcare,Biologyand Classification). 1st Edition,Cassell Pvt., London .240 pp.
2. Adey,W.H.andK.Loveland,1998.DynamicAquariaBuildingLivingEcosystems.2nd Edition, Academic Press,US. 498 pp.
3. Axelrod,H.RandL.P.Schultz,2000.HandbookoftrophicalaquariumFishes.1stEdition, orinocobooks - Sheffield SYK United Kingdom. 717 pp.
4. Grist,C.,D.Millsand A.Caine,2002,hePracticalEncyclopediaoftheMarineAquarium. Interpet Publishing-US. 208 pp.
5. Kuravamveli,S.J.,2002.TheAquariumHandbook.1stEdition,AmityAquatechpvt.Ltd Cochin. 256 pp.
6. HemdalJ.F.,2003.AquariumFishBreeding.1stEdition,Barron'sEducationalSeries-US.176 pp.
7. Stephen Spotte,2005 . Marine Aquarium Keeping theScience Animals and Art. LasVegas, 1st Edition,NV,USA. 171 pp.
8. Sundararaj,VandJ.M.Sathish,2005.Tropicalmarineaquarium.1stEdition,Yegam publications, Chennai. 160 pp.
9. FletcherA.M.,2006.unusualaquariumFishes.1stEdition,Mishawaka,IN,USA.397pp.
10. Yoan,N.,2011.Live-BearingAquariumFish.1stEdition,MissPress,US.52pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandfreshwaterandmarineaquariumstatus,ornamentalfishtrade,aquarium  fishesandcollectionstrategies. |
| CO2: | Toviewtheculturingpracticesandhatcherytechniquesandlivefeedculture. |
| CO3: | Tounderstandthedesigningoffishtanks,aeration,filtrationandlightingsetupinthe  aquariumtanks. |
| CO4: | Tounderstandthesettingofaquariumtanksanddecorationinindoorandoutdoor  aquariumtanks. |
| CO5: | Tounderstandthepreparationofpelletfeedanddiseasemanagementintheaquarium  fishes. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** |  |  |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** |  |  |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **12** | **12** | **09** | **09** | **15** | **15** | **09** |

**-Projectwork**

**Semester-IV Credits:8**

**DepartmentElectives(DE)**

**LearningObjective(LO):**

**DisasterManagement**

## Credits:3

**Hours:3**

LO1**:** To study the coastal hazards, risk assessment and disaster management strategies in India. LO2: To study the types of hazards in fisheries sector and other impact of natural disasters and assessment.

LO3:Tostudythedisastermanagementstrategiesduringthepre-disasterandpostdisaster periods.

LO4:Tostudytheresponseandrecoverysystemsatnational,stateandlocal, coordination between different agencies.

LO5:TostudythePrevalentnationalandglobalmanagementpracticesindisaster managements.

# UNITI

Basicconcepts-Basicconcepts:Hazard,risk,vulnerability,disaster,capacitybuilding.

Multi-hazardanddisastervulnerabilityofIndia.

# UNITII

Various disasters - Types of natural and manmade hazards in fisheries and aquaculture- cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio- diversity etc. Causes, characteristics and impact of various disasters.

# UNITIII

Disaster Management strategies - Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; differentwaysofdetectingandpredictingdisasters;earlywarning,communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures.

# UNITIV

Response and recovery systems - During disaster: response and recovery systemsatnational,stateandlocal,coordinationbetweendifferentagencies,

internationalbestpractices.Post-disaster:Methodsforassessmentofinitialand long term damages, reconstruction and rehabilitation.

# UNITV

Agencies in disaster management - Prevalent national and global management practices in disaster management. Agencies involved in monitoring and earlywarningsatdistrict,state,nationalandgloballevels.Seasafety andhealth.

# REFERENCEBOOKS

1. HarshK.Gupta,2003.DisaterManagemnet,Universitypress,152pp.
2. Damon P. Coppola, 2015. Introduction to International Disaster Management, Butterworth- Heinemann, 760pp.
3. I.SundarT.Sezhiyan,2007.DisasterManagement,Sarup&Sons,182pp.
4. JackPinkowski,2008.DisasterManagementHandbook,CRCPress,624pp.
5. RajivSinha,RasikRavindra,2012.EarthSystemProcessesandDisasterManagement,Springer Science & Business Media, 244pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandcoastalhazards,riskassessmentanddisastermanagementstrategiesin  India |
| CO2: | Tounderstandthetypesofhazardsinfisheriessectorandotherimpactofnatural  disastersandassessment. |
| CO3: | Tounderstandthedisastermanagementstrategiesduringthepre-disasterandpost  disasterperiods. |
| CO4: | Tounderstandtheresponseandrecoverysystemsatnational,stateandlocal,  coordinationbetweendifferentagencies |
| CO5: | TounderstandthePrevalentnationalandglobalmanagementpracticesin  disastermanagements. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** |  | **3** |  | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** |  | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **12** | **09** | **09** | **15** | **15** | **09** |

**LearningObjetives(LO):**

**MarineFoodTechnology**

## Credits:3

**Hours:3**

**LO1:**Tostudythepreservationandprocessingmethodsandtypeofpreservativesinfishprocessing.

LO2:Tostudythepackingmethods,utilizationandpreparationoffisheryby-products.

LO3:Tostudythespoilageofseafoodcausedbymircroorganismsandtheircontrollmeasures. LO4:Tostudythequlalitymanagementoffisheryproductsandcertificationapproachesfor commerical applications.

LO5: To study the product development and nutrition promotion, consumer studies qualitativeand quantitative research methods.

## UnitI

Preservation and processing – chilling methods, phenomena of rigor mortis, spoilage changes – causative factors. Drying – conventional methods. Salt curing, pickling and smoking. Freezing and cold storage, Canning procedures. Role of preservatives in processing.

## UnitII

Packing – handling fresh fish, frozen packs, IQF, layered and shatter packs. Fishery by – products, cannery waste, feeds, silage, fish gelatin, fish glue, chitin and chitosan, pearl essence, fertilizer.

## UnitIII

Seafood microbiology – factors influencing microbial growth and activity. Seafood borne pathogens – bacteria, fungi, viruses. Spoilage factors in seafood. Toxins influencing food spoilage. Microbes as food – SCP, microbial neutraceuticals.

## UnitIV

Quality management – concepts, planning, system, quality control, quality assurance, quality improvement. Certification standards – ISO and HACCP. Principles of quality related to food sanitation, contamination, pest control, human resource and occupational hazards.

## UnitV

Novel product development, marketing and sea food export – MPEDA, marketing, government policies, export finance, economic importance. Novel products – nutrition promotion, consumer studies qualitative and quantitative research methods

# REFERENCEBOOKS

1. Kreuzer,R.,1974.FisheryProducts,FAOFishingNews(Books)Ltd.,England,280pp.
2. Anon,1979.Handling,ProcessingandMarketingofTropicalFish.TropicalProductsInstitute, London.
3. Miller,M.D.,1990.CiguateraSeafoodToxins,CRCPressNewYork.
4. Carison,V.R.andR.H.Graves,1996.AsepticProcessingandPackingofFood:AFood Industry Perspective, CRC Press, New York.
5. Gopakumar, K., 1997. Tropical Fishery Products. Oxford & IBH Publications, New Delhi, 190 pp.
6. Chandran,K.K.,2000.PostHarvestTechnologyofFishandFisheryProducts,Daya Publishing House, New Delhi, 440 pp.
7. Wilson,C.L.,S.Droby,2000.Microbialfoodcontamination,CRCPress,NewYork.
8. Balachandran,K.K,2001.PostHarvestTechnologyoffishandfishproducts,Daya Publishing House, New Delhi 440 pp.
9. Novak, J.S., G.M. Sapres and V.K. Juneja, 2002. Microbial safety of minimally processedfoods, CRC Press, New York.
10. Weidenborner,M.,2003.Encyclopediaoffoodmycotoxins,SpringerVerlag,USA.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthepreservationandprocessingmethodsandtypeofpreservativesinfish  processing. |
| CO2: | Tounderstandthepackingmethods,utilizationandpreparationoffisheryby-products. |
| CO3: | Tounderstandthespoilageofseafoodcausedbymircroorganismsandtheircontroll  measures. |
| CO4: | Tounderstandthequlalitymanagementoffishery productsandcertificationapproaches  forcommericalapplications. |
| CO5: | Tounderstandtheproductdevelopmentandnutritionpromotion,consumerstudies  qualitativeandquantitativeresearchmethods |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** |  |  |  | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** |  | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **12** | **15** | **09** | **09** | **15** | **15** | **09** |

**MicrobialTechnology**

**LearningObjective(LO):**

**Credits:3**

**Hours:3**

**LO1:**Tostudytheisolationandscreeningofindustrialimportantmicrobesandstrain development for commercial agents.

LO2:Tostudytheprinciplesofbioprocesstechnologyandoptimizationforproduct

development.

LO3:Tostudytherecombinantproteinproductinmicrobesandtheirissuesincommercial production.

LO4:Tostudythebioremediationofmicrobesandtheirsignificantroleintoxicwasteremoval and ore leaching.

LO5:Tostudytheapplicationofmicrobesinfoodandhealthcareindustries, foodprocessingand food preservation approaches.

## UnitI

Isolationandscreeningofindustriallyimportantmicrobes;Largescalecultivationof

industrial microbes;Strain improvementtoimprove yieldofselectedcompoundse.g.antibiotics, enzymes or recombinant proteins.

## UnitII

Basicprinciplesofbioprocessasappliedtoselectedmicrobes;Processoptimizationof

selectedproducts.

## UnitIII

Recombinant protein production in microbes ; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast)

## UnitIV

Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

## UnitV

Microbialapplicationinfoodandhealthcareindustries;Foodprocessingandfood

preservation;Antibioticsandenzymesofpharmaceuticaluse.

# REFERENCEBOOKS

1. Peter F. Stanbury, 1999, Principles of Fermentation Technology, Butterworth- Heinemann Publishing, UK, 376 pp.
2. Young M.M ,2004.Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4.., Elsevier India Private Ltd, India.
3. Glazer and Nikaids, 2007, Microbial Biotechnology, 2nd Edition, Cambridge University Press, UK, 576 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandtheisolationandscreeningofindustrialimportantmicrobesandstrain  developmentforcommercialagents. |
| CO2: | Tounderstandtheprinciplesofbioprocesstechnologyandoptimizationforproduct development |
| CO3: | Tounderstandtherecombinantproteinproductinmicrobesandtheirissuesin  commercialproduction. |
| CO4: | Tounderstandthebioremediationofmicrobesandtheirsignificantroleintoxicwaste  removalandoreleaching. |
| CO5: | Tounderstandtheapplicationofmicrobesinfoodandhealthcareindustries,food |

|  |  |
| --- | --- |
|  | processingandfoodpreservationapproaches. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** |  |  | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO5** | **3** |  | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **12** | **09** | **09** | **15** | **15** | **09** |

# REMOTESENSING&GIS

**LearningObjective(LO):**

**Credits:3**

**Hours:3**

**LO1:** To study the principles and applications of remote sensing and types of sensors and their applications.

LO2:Tostudytheapplicationofremotesensingintheassessmentofmarinefloraandocean colour monitoring.

LO3:TostudytheprinciplesandapplicationsofGISandmappingofmarineresourcesbyusing the GIS tools.

LO4:TostudythespatialAnalysis,IntegrationandmodellingstrategiesandconceptofWeb GIS.

LO5:Tostudythemarineresourcesexploration,MappingandMarineResourcesinformation System.

## Unit–I

Introduction to Remote Sensing: Definition of terms, Concepts and types of remote sensing; evolution of remote sensing technology- Electromagnetic spectrum- Atmospheric windows. Types of **Sensors**- passive sensors and active sensors; characteristics of optical sensors;Sensors resolution – spectral, spatial, radiometric and temporal; Thermal Remote sensing,MicrowaveRemoteSensing andHyper-spectral RemoteSensing.Satellitesandsensors: IRS, Landsat, NOAA, MODIS- LISS, AWIFS, AVHRR, TM, OCM, MODIS and Hypriyan.

## Unit–II

Application of remote sensing in the assessment of mangroves, coral reef, seaweed and sea grasses.Ocean Color Monitoring and productivity studies; Sea surface temperature and Oceanographic parameters: eddies, ocean circulation, upwelling and identification of Potential Fishing Zone (PFZ),

## Unit-III

Introduction to GIS: Definitions, Basic Concepts, Data- Types and Models: Spatial, Geometrical Data – Raster data, Vector data, Non-spatial, Attribute Data.Advantages and disadvantages of raster vector data formats. Models of data:- Basic Data Models- raster and vector, Spaghetti model and Topology model; Advanced data models– Grid model, TIN model and DEM.

Map scanning and digitizing, topology building, editing and cleaning. Data processing: Updation, corrections, modifications, scale change, geometric transformations and map projection transformations,conflation sliver removal, edge matching, interactivegraphic editing, rubber sheeting.

## Unit-IV

Spatial Analysis, Integration and Modelling: Logic operations, general arithmetic operations, general statistical operations, geometric operations, query and report generation from attribute data, geometric data search and retrieval, classification reclassification, integrated geometry and attributes, overlay, buffer zones, raster data overlay. Definition and concept of Web GIS- advantage and limitations of Web GIS, overview of WebGIS.

## UnitV

Applications in Marine sciences: Marine resources exploration, Mapping and Marine Resources information System; GIS in Marine and Coastal Zone Management. Mapping and monitoring of pollution, changes in coastal zones, Applications in Disaster Management: Tsunami – types, causes, RS and GIS applications for post Tsunami damage assessment and rehabilitation. Creating custom GIS Software applications and user interface.

# REFERENCEBOOKS

1. Ramachandran, S., 2000. Marine remote sensing applications. Institute for Ocean Management, Anna University.
2. Lillesand,T.M.andR.W.Kefer,2000.RemoteSensingand image interpretation.John Wiley & Sons. Inc.
3. Anji Reddy, M., 2000. Remote sensing and Geographical Information System. The Book Syndicate, Hydrabad.
4. Lucas, L.F. Janseen, Wim H. Bakker, Ben G.H. Gorte, John A. Horn, Christine Pohl,Anupma Prakash, Colin V. Reeves, Michael J.C. Weir, TsehaieWoldai, 2001. Principals of Remote Sensing An Introductory Text Box, 2ndedition, ITC Educational Textbook Series.
5. Rolf A de By, Martin C. Wllis, Yola Georgiadou, Wolfgang Kainz, Richard, A. Knippers, Menno-Jan Kraak, Mostafa M. Radwan, Edmund J. Sides, Yuxian Sun, Michael J.C. Weir and Cees J. van Westen, 2001. Principals of Geographic Information Systems: An introductory textbook. 2ndedition. , ITC Educational Textbook Series.
6. Yeqiao,Wang,2009.RemoteSensingofcoastalenvironments.Taylor&Francis,CRCPress, 457 pp.
7. Michael Kennedy, 2009. Introducing Geographic Information systems withArcGIS: A workbook approach to learning GIS, 2ndedition, Wiley publications, 624 pp.
8. PindeFuandJiulinSun,2010.WebGIS:PrinciplesandApplications.ESRI,312pp.
9. ChristianHarder,2011.UnderstandingGIS:AnArcGISProjectworkbook,ESRI,378pp.
10. Vasilis, D.Valavanis, 2011. Marine Geographical Information Systems: Theory and Applications (Advances in Geographic Information Science), Springer, 500 pp.

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandtheprinciplesandapplicationsofremotesensingandtypesofsensorsand  theirapplications. |
| CO2: | Tounderstandtheapplicationofremotesensingintheassessmentofmarinefloraand ocean colour monitoring. |
| CO3: | TounderstandtheprinciplesandapplicationsofGISandmappingofmarineresources  byusingtheGIStools. |
| CO4: | TounderstandthespatialAnalysis,Integrationandmodellingstrategiesandconceptof  WebGIS. |
| CO5: | Tounderstandmarineresourcesexploration,MappingandMarineResourcesinformation  System. |

**OutcomeMapping**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  |  |  | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **CO5** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **Total** | **15** | **15** | **12** | **09** | **15** | **15** | **09** |

**InterDepartmentalElectives(IDE)**

**SoftSkillDevelopment**

**Credits:3**

**Hours:3**

**LearningObjective(LO):**

**LO1:**Tolearnthecommunicationsskills,interpretingtheverbalandnonverbalcues.

**LO2:** To learn the presentation skills, preparation and participation of group discussions. **LO3:**Tolearnthetechnicalwritingskills,preparationofabstract,results,discussionanddata interpretation.

**LO4:**TolearntheapplicationsofcomputerskillsbrowsingsearchenginesHidden Webandits importance in scientific research.

## UnitI:IntroductiontoSoftSkills

Whataresoftskills?-Whatarehardskills?-Importanceofsoftskills-Importanceof knowingyourself-SWOTAnalysisanditsbenefits-Developingpositiveattitude-Powerof positive attitude-overcoming negative attitude.

## UnitII:EffectiveCommunication

Meaning of Effective Communication-Verbal and non-verbal communication-Kinesis- Art of Effective Listening-Types of Listening-Barriers to Listening-Advantages of Active Listening- Art of public speech-Language and proficiency in public speech-Spoken English- Fluency-Benefits of Reading-Different types of Reading-Becoming an Effective Reader.

## UnitIII:BusinessCommunication

Strategies of Good writing-Mechanics of Good writing-use of punctuation-Business letters-Writing Memo-Short reports-Agenda-Minutes-Business Proposals.

## UnitIV:EmployabilitySkills

Definition of Interview-Types of Interviews-Typical Questions asked in Interviews-Job Application-CV preparation-Types of Resume-Group Discussion-Essential elements of Group Discussion-Skills required in Group Discussion-Group Discussion Etiquette

## UnitV:ProfessionalSkills

Leadership Qualities-Decision making-Time Management-Stress Management-Problem Solving-Team Building and Team work

## SupplementaryReading:

* AlexK.*SoftSkills*NewDelhi:S.Chand&Co.,2016
* Ghosh,B.N*Managing Soft Skills for Personality Development* New Delhi: Tata McGraw Hill, 2012
* KrishnaMohanandMeeraBanarji.*DevelopingCommunicationSkills.*NewDelhi: Macmillan,2009
* NeeraJainandShomaMukherji.*EffectiveBusinessCommunication.*NewDelhi:Tata McGraw Hill,2012
* Rao, M.S.*Soft Skills-EnhancingEmployability*: *ConnectingCampus withCorporate*. New Delhi: LK Publishing House, 2011
* Rizwi,AshrafM.*EffectiveTechnicalCommunication.*NewDelhi:TataMcGraw Hill,2010

## CourseOutcomes

Attheendofthecourse,thestudentwillbeableto

|  |  |
| --- | --- |
| CO1: | Tounderstandthecommunicationsskills. |
| CO2: | Tounderstandthepresentationskills,preparationandparticipationmethods. |
| CO3: | Tounderstandthetechnicalwritingskills. |
| CO4: | Tounderstandtheapplicationsofcomputerandbrowsingsearchengines. |

## OutcomeMapping

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CO/**  **PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** |  | **3** | **3** |  | **3** | **3** | **3** | **3** | **3** | **3** |  |
| **CO2** | **3** |  | **3** |  |  | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** |  | **3** |  | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |  | **3** | **3** | **3** | **3** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **CO1** | **3** | **3** | **3** | **3** | **3** | **3** |  |
| **CO2** | **3** | **3** | **3** |  | **3** | **3** |  |
| **CO3** | **3** | **3** | **3** | **3** | **3** | **3** | **3** |
| **CO4** | **3** | **3** |  | **3** | **3** | **3** | **3** |
| **Total** | **12** | **12** | **09** | **09** | **12** | **12** | **06** |

**CO-POMAPPINGSCORES**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **CoursesImpact** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PSO7** |
| **1** | **15** | **15** | **09** | **09** | **15** | **15** | **09** |
| **2** | **12** | **09** | **09** | **09** | **15** | **09** | **06** |
| **3** | **15** | **15** | **09** | **09** | **09** | **09** | **09** |
| **4** | **15** | **09** | **09** | **09** | **09** | **09** | **09** |
| **5** | **09** | **12** | **09** | **09** | **15** | **12** | **09** |
| **6** | **12** | **12** | **09** | **09** | **15** | **15** | **09** |
| **7** | **15** | **15** | **09** | **09** | **15** | **15** | **09** |
| **8** | **12** | **15** | **09** | **09** | **15** | **15** | **09** |
| **9** | **12** | **12** | **09** | **09** | **15** | **15** | **09** |
| **10** | **15** | **15** | **06** | **06** | **12** | **15** | **09** |
| **11** | **12** | **12** | **06** | **09** | **15** | **12** | **06** |
| **12** | **15** | **15** | **09** | **09** | **12** | **12** | **06** |
| **13** | **15** | **15** | **09** | **09** | **15** | **15** | **09** |
| **14** | **12** | **15** | **09** | **09** | **15** | **09** | **09** |
| **15** | **12** | **12** | **09** | **09** | **15** | **15** | **09** |
| **TotalScore** | **198** | **198** | **129** | **132** | **207** | **192** | **126** |