Annamalai University
(Accredited with 'A' Grade by NAAC)

MARINE BIOLOGY AND OCEANOGRAPHY
(Two – Year) Programme

Regulations & Curriculum

2019-2020

CAS in Marine Biology
FACULTY OF MARINE SCIENCES

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE TWO-YEAR POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculty of Marine Sciences from the academic year 2019-2020 onwards.

1. Definitions and Nomenclature

1.1 University refers to Annamalai University.

1.2 Department means any of the academic departments and academic centres at the University.

1.3 Discipline refers to the specialization or branch of knowledge taught and researched in higher education in the Marine Sciences.

1.4 Programme encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 Course is an individual subject in a programme. Each course may consist of Lectures/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 Curriculum encompasses the totality of student experiences that occur during the educational process.

1.7 Syllabus is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 Academic Year refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 Semester is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 Choice Based Credit System A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 Core Course is mandatory and an essential requirement to qualify for the Degree.

1.12 Elective Course is a course that a student can choose from a range of alternatives.

1.13 Value-added Courses are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 Credit refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The Credit value reflects the content and duration of a particular course in the curriculum.

1.15 Credit Hour refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular class.

1.16 Programme Outcomes (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 Programme Specific Outcomes (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 Learning Objectives also known as Course Objectives are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

1.19 Course Outcomes (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 Grade Point Average (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 Cumulative Grade Point Average (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

1.22 Letter Grade is an index of the performance of a student in a particular course. Grades are denoted by letters S, A, B, C, D, E, RA, and W.

2. Programmes Offered and Eligibility Criteria

Faculty of Marine Sciences	
M.Sc. Marine Biology & Oceanography	A undergraduate degree in Zoology / Zoology (Vocational) / Fishery Science / B.F.Sc. / Industrial Fish and Fisheries with Zoology as a subsidiary subject) / Advanced Zoology and Biotechnology with a minimum of 50% of marks in Part-III or any other degrees recognized equivalent to Zoology. [M.Sc. Marine Biology and Oceanography (with B.Sc. Zoology as major) awarded by Annamalai University is equivalent to M.Sc. Zoology (G.O.Ms.) No. 116 dated 22.07.2014)]

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for the above Programme.

3. Reservation Policy

Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programmes consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental) and Project.

5.2 Core courses

5.2.1. These are a set of compulsory courses essential for each programme.

5.2.2. The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 **Department Electives (DEs)** are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2 **Interdepartment Electives (IDEs)** are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.3.3 **Each student shall take a combination of both DEs and IDEs.**

5.4 Experimental Learning

5.4.1 Experimental Learning provides opportunities to students to connect principles of the discipline with real-life situation.

5.4.2 In-plant training / field trips / internships / industrial visits 3as applicable) fall under this category

5.4.3 Experimental learning is categorised as core

5.5 Project

5.5.1 Each student shall undertake a Project in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the University website and in the Handbook on Interdepartmental Electives and VACs.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.6.4 Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

5.7 Online Courses

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 Credit Distribution

The credit distribution is organised as follows:

	Credits
Core Courses	65-75
Elective courses	15
Project	6-8
Total (Minimum requirement for award of Degree)	**90-95***

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 90-95 credits.*

5.9 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of *Attendance and Assessment Record* for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organisation of lesson plan of the Course Instructor.

6.3 The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student should have at least 75% attendance in the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extra-curricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class test, assignment, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment and the procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test – I will cover the syllabus of the first two Units while CIA Test – II will cover the last three Units.

8.4.5 CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6. A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first/third semester will be conducted in November and for the second/fourth semester in May.

8.5.2 A candidate who does not pass the examination in any courses of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1. Each course, both Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will constitute 40% and the ESE 60% of the marks.

9.2. Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test – I	10
Test – II	10
Seminar	03
Assignment	02
Total	25

9.2.3 For the Practical Courses 3wherever applicable), the break-up of marks shall be as follows:

	Marks
Test – I	15
Test – II	15
Viva-voce and Record	10
Total	40

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by both External and Internal examiners (Double Evaluation).

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and Viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project evaluation Committee will comprise the Head of the Department, Project Supervisor and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (30 Marks)		End Semester Examination (70 Marks)			
		Thesis Evaluation (40)		Viva-voce (30)	
Review-I 15	Review-II: 15	Internal	External	Internal	External
		20	20	15	15

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal.

9.5.2 Two CIA Tests shall be conducted during the semester by the Departments offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed from the first semester to the current semester.

11.3 The GPA is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where 'C_i' is the Credit earned for the Course i in any semester;

'G_i' is the Grade Point obtained by the student for the Course i and

'n' is the number of Courses passed in that semester.

11.4. CGPA is the weighted average Grade Point of all the Courses passed starting from the first semester to the current semester.

Where GG is the Credit earned for the course G in any semester

GG is the Grade point obtained by the student for the Course G

G is the number of courses passed in that semester

G is the number of semesters

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

Letter Grade	Grade Points	Marks %
S	10	90 and above
A	9	80-89
B	8	70-79
C	7	60-69
D	6	55-59
E	5	50-54
RA	0	Less than 50
W	0	Withdrawn from the examination

11.6 Classification of Results. The successful candidates are classified as follows:

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme *in the first attempt* with a CGPA of 8.25 or above within

the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details)

11.6.2 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5

11.6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.7 Course-Wise Letter Grades

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in **ANY ONE** of the semesters **ONLY** for exigencies deemed valid by the University authorities.

12.3. Permission to withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4. Application for withdrawal shall be considered **only** if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5. The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal is **not** granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First class with Distinction.

13. Academic misconduct

Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitised on issues of academic integrity and ethics.

14. Transitory Regulations

Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted three consecutive times after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two year Master's Programme at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendation of the Academic Council.

Annamalai University

Centre of Advanced Study in Marine Biology
M.Sc. Marine Biology and Oceanography (Two Year) Programme
Programme Code: CMAB21
Programme Structure
(For students admitted from the academic year 2019-2020)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19MBOC 101	Invertebrates and Prochordates	3		3	25	75	100
19MBOC 102	Vertebrates	3		3	25	75	100
19MBOC 103	Cytology, Genetics and Immunology	4		4	25	75	100
19MBOC 104	Marine Microbiology	3		3	25	75	100
19MBOC 105	Physiology and Biochemistry	4		4	25	75	100
19MBOE 106	Elective – I (IDE)	3		3	25	75	100
19MBOP 107	Practical – I (19MBOC 101,102 & 105)		6	3	40	60	100
19MBOP 108	Practical – II (19MBOC 103 & 104)		4	2	40	60	100
				25			
Semester-II							
19MBOC201	Physical Oceanography	3		3	25	75	100
19MBOC202	Chemical Oceanography	3		3	25	75	100
19MBOC203	Biological Oceanography	3		3	25	75	100
19MBOC204	Coastal Aquaculture	3		3	25	75	100
19MBOC205	Fisheries Science and Statistics	4		4	25	75	100
19MBOP206	Practical – III (19MBOC 201& 202)		6	3	40	60	100
19MBOP207	Practical – IV (19MBOC 203 & 204)		6	3	40	60	100
19MBOP208	Practical – V (19MBOC 205)		2	1	40	60	100
				23			

Semester-III							
19MBOC301	Marine Ecology & Zoogeography	4		4	25	75	100
19MBOC302	Marine Biotechnology, Bioinformatics & Instrumentation	4		4	25	75	100
19MBOC303	Pollution and Toxicology	4		4	25	75	100
19MBOC304	Ocean Management	4		4	25	75	100
19MBOE305	Elective – II (DE)	3		3	25	75	100
19MBOE306	Elective – III (DE)	3		3	25	75	100
19MBOP307	Practical – VI (19MBOC 301& 302)		6	3	40	60	100
19MBOP308	Practical – VII (19MBOC 303)		2	1	40	60	100
				26			
Semester-IV							
19MBOC401	Ornamental Fish culture & Aquarium Keeping	4		4	25	75	100
19MBOE402	Elective – IV (DE)	3		3	25	75	100
19MBOE403	Elective – V (DE)	3		3	25	75	100
19MBOP404	Project Work			8	30	70	100
				18			
	Total Credits			**92**			
	Value Added Courses						
	On-line courses (SWAYAM, MOOC and NPTEL)						

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.
2. Students may opt for any Value-added Courses listed in the University website.

Elective Courses

Department Electives (DE)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
19MBOE 305	Disaster Management	3		3	25	75	100
19MBOE 306	Marine Food Technology	3		3	25	75	100
19MBOE 402	Microbial Technology	3		3	25	75	100
19MBOE 403	Remote Sensing	3		3	25	75	100

Inter Departmental Electives (IDE)

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
19MBOE 106	Soft Skill Development	3		3	25	75	100

Programme Outcomes

PO1:	The Faculty of Marine Sciences will endeavor to continue a world class master program in Marine biology and oceanography with experts in the subject areas being taught, including the recent research areas and are passionate when working with students in undergraduate and post graduate levels.
PO2:	The Marine Science faculty will continue to review, update and revise the curriculum to ensure the quality of syllabus in commendable level.
PO3:	Students graduating with a Master degree in Marine Biology and Oceanography should be skilled in the advance level of marine sciences.
PO4:	Students graduating with a Master degree Marine Biology and Oceanography will be trained to involve in research program and other job opportunities.
PO5:	Students graduating in a Marine Biology with master level dissertation work/pre research experience will ensure their future become a Scientist, R&D experts, teachers and field experts.

Programme Specific Outcomes

At the end of the programme, the student will be able to

PSO1:	Impart the complete knowledge about the fundamentals of Marine Sciences including the biological, chemical and physical oceanography.
PSO2:	Explore the basics of oceans in terms of waves, tides, current and chemical properties of sea water.
PSO3:	Taught the origin of ocean and diversity of marine organisms which including the marine microbes, marine flora and fauna.
PSO4:	Gain the knowledge about the taxonomy of marine organisms by using the conventional method and advanced level of molecular methods.
PSO5:	Prepare the students not only the biological information and train the various techniques/instruments viz., Knudesen sampler, Bathy meter, hydrometer, Seichi disc, Spectrometer, Gel Doc, HPLC, FTIR etc.
PSO6:	Carry out the various experiments for water quality; enumerate the primary producers, monitoring the marine pollution, biodegradation, probe development and microbial identification.
PSO7:	Practice the students with proficient in culture of marine organisms, utilization of marine resources to make as an entrepreneur and national & international level researcher.

Semester-I **19MBOC101: INVERTEBRATES AND PROCHORDATES**
(Functional morphology, Palaeontology and Evolution) **Credits: 3**

Hours:3

Learning Objective (LO):

LO1: To understand Geological time scale, chordate features and theories on origin of chordates.
LO2: To learn about origin and distribution of amphibia**.**
LO3: To understand adaptive radiation of contemporary reptiles, turtles and amphibian.
LO4: To learn the general characters of mammals and evolution of monotremes, marsupials and placentals.
LO5: To understand gamatogenesis, fertilization, cleavage and development upto gastrulation in Amphioxus.

UNIT 1 – Protozoa and Coelenterata

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

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

UNIT 2 – Minor phyla

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

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

UNIT 3 – Crustacea and Polychaeta

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

Polychaeta – classification, morphology, feeding methods - reproduction and adaptive radiation.

UNIT 4 - Mollusca

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

UNIT 5 – Echinodermata and Prochordata

Echinodermata – Classification, structure and function, water vascular system, regeneration, reproduction and larval forms.

Prochordata – classification and comparative morphology, reproduction and early development, larval metamorphosis.

Practical

1. Identification of locally available invertebrate fauna
2. Mounting of gastropod radula

3. Digestive system in gastropods and bivalves
4. Crystalline style of bivalves
5. Identification of sex in crustaceans and molluscs
6. Mouth parts of *Squilla* and *Balanus*.
7. Study of digestive, nervous, reproductive systems and different ovarian maturity stages in Shrimp
8. Appendages of prawns, shrimps and crabs
9. Study of water vascular system, tube feet and Aristotle's lantern in sea stars

Text Books

1. Hyman, l., 1967. The Invertebrates Vols, I to VI. McGraw Hill Book Co. Ltd., New York, 792 pp.
2. Kaestner, A., 1967-1970 Invertebrate Zoology Vols. 1-(1967-472pp),Vol.2 (1968-472pp)Vol.3 (1970-523pp). Wiley Interscience Publishers, New York.
3. Barnes, R.D., 1980. Invertebrate Zoology. 4th Edition. Saunders College Publishers, Philadelphia, 534 pp.
4. Ruppert, E.E. and R.D. Barnes, 1994. Invertebrate Zoology 6th Edition. Saunders College Publishers, Philadelphia, 1056 pp.
5. Adiyodi, K.G. and K.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. Modern Text book of Zoology invertebrates. 10th Edition. 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.

Supplementary Reading

1. James R. Garey and Andreas Schmidt-Rhaesa 31998). The Essential Role Of "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 neritopsine gastropods estimated from 28S rRNA sequences and fossil records. *The Royal Society.*

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the classification of Phylum: Coelenterates/Cnidaria and the development of metamorphosis.
CO2:	To understand the functional morphology of minor phyla and their classification & development.
CO3:	To understand the classification of Crustacea and Polychaetes with their developmental stages.
CO4:	To understand the classification and importance of Phylum Mollusca.
CO5:	To understand the classification of Echinodermata and Prochordata with their development.

Outcome Mapping

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 **19MBOC 102 – VERTEBRATES** **Credits: 3**

(Functional morphology, Palaeontology, Developmental Biology and Evolution) **Hours: 3**

Learning Objective (LO):

LO1: To understand Geological time scale, chordate features and theories on origin of chordates.
LO2: To learn about origin and distribution of amphibia**.**
LO3: To understand adaptive radiation of contemporary reptiles, turtles and amphibian.
LO4: To learn the general characters of mammals and evolution of monotremes, marsupials and placentals.
LO5: To understand gamatogenesis, fertilization, cleavage and development upto gastrulation in Amphioxus.

UNIT 1 – Origin of chordates

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

UNIT 2 –Bony fishes and Amphibia

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.

UNIT 3 – Reptiles and Marine birds

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

Importance of marine birds, adaptations to the marine environment, migration.

UNIT 4 – Evolution of Mammals and human

General characters of mammals – classification and evolution of monotremes, marsupials and placentals, human evolution, aquatic mammals – classification, adaptations and evolution of Cetacea and Sirenia. Seals, Walruses and Sea otters.

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

UNIT 5 – Developmental Biology

Gametogenesis, fertilization, cleavage, development upto gastrulation in Amphioxus. Embryology (with special reference to marine vertebrates viz., fish, bird and mammal).

Practical

1. Functional morphology of respiratory organs- aquatic animals - gills of cartilagenous and bony fishes
2. Study of important vertebrates specimen representing phylum Pisces to Mammalia
3. Early embryonic developmental stages of fish .- Larval stages
4. Mounting of scales of fishes.
5. Baleen plates of whales
6. Osteological observation of fishes and marine mammals
7. Marine turtles
    a. Green turtle
    b. Oliver ridley turtle
    c. Hawksbill turtle
    d. Leathery turtle
    e. Loggerhead turtle
8. Preparation of field report.

Text Books

1. Robert T. Orr, 1976. Vertebrate Biology. 3rd Edition, W.B. Saunders Company, Philadelphia p. 472.
2. Young, J.Z., 1981. The Life of Vertebrates. Oxford University Press, New York, 568 pp.
3. Minkoff, E.C., 1983. Evolutionary Biology, Addison Wesley Publishing Company, Massachusetts, 627 pp.
4. Romer, A.S. and T.S.Parsons, 1986. The Vertebrate body, 6th edition, Philadelphia Soundrs VII + 679pp.
5. Colbert, Edwin, H. 1989. Evolution of the vertebrates. Wiley Eastern Ltd., New Delhi. P. 535.
6. Strickberger, W. Monroe, 1996. Evolution. Jones and Barlett Publishers, Massachusetts, p. 670.
7. Gilbert, F. Scott, 2000. Developmental Biology, 6th edition, Sinauer Associates, Inc., Publishers, Massachusetts, p. 749.
8. Kenneth Kardong, 2001. Vertebrates; Comparative anatomy function, evoluation. McGraw Hill Science 3rd edition, 784pp.
9. Edward, J.Z., 2006. Comparative Vertebrate anatomy: a laboratory dissection guide. McGraw Hill, 226p.

Supplementary Reading

1. Colbert, E.H., 2015. Evolution Of Vertebrates (510 Pp).
2. Seshappa, G., 2018. Indian Marine Biology (154pp).
3. George L. Hunt Jr., 1990. The pelagic distribution of marine birds in a heterogeneous environment. Polar Research, 8:1, 43-54.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the origin of chordates by time scale and features.
CO2:	To understand the origin of Amphibia and Bony fishes.
CO3:	To understand the origin and adaptive radiation of Reptiles and Birds.
CO4:	To understand the evaluation of Marine Mammals and human.
CO5:	To understand the marine developmental stages of vertebrate's viz., fish, bird and mammals.

Outcome Mapping

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-I 19MBOC 103 – CYTOLOGY, GENETICS AND IMMUNOLOGY

Credits: 4
Hours: 4

Learning Objective (LO):

LO1: To learn about microscopes- light, phase contrast and interference, 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: To learn about normal and transformed cell lines as model genetic systems and advantages.

LO4: To learn about non- specific immune response, Immunological factors- humoral and clotting.

LO5: To learn about the elements of Immunolgy, Antigen, antigenicity, epitopes and haptens.

UNIT I – Microscopy and cellular organisation

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.

UNIT II – Genetic techniques

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 reversal and ploidy. aquaculture applications, Cryopreservation, conservation of germplasm.

UNIT III- Model genetics systems

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

Normal and transformed cell lines as model genetic systems – advantages.

UNIT IV – Immunology – Invertebrates (Crustaceans)

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

UNIT V – 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 electron microscope
2. Giant chromosomal preparation (Squash)
3. Types of Cells
4. Preparation of stages of cell division
5. Cell organelles (Slides)
6. Fish chromosome mounting
7. Blood cell count and identification of lymphoid cells in blood smears
8. Antigen and antibody reaction & Haemagglutination
9. Immuno electrophoretic techniques
10. ELISA
11. Cell division – Mitosis and Meiosis
12. Calibration and use of Stage and Ocular Micrometers and Measuring microscopic organisms

TEXT BOOKS

1. Strachan,T. and A.P.Read, 2004. Human Molecular Genetics, 3rd Edition, Wiley Publications, 674pp.
2. Gahalain,S.S., 2004 Fundamentals of Genetics, Anmol Publications Pvt. Ltd., 603pp.
3. Sambamurthy, A.V.V.S. 2005, Genetics, Alpha Science International, 9003 pp.
4. Male,D., Brostoff,J., Roth,D.B., Roitt, M.I. 2006 Immunology, Elsevier Publications, 552pp, 7th Edition.
5. Prakash,M. 2007 Molecular Genetics, Discovery Publishing House, New Delhi, 332pp.
6. Lodish, Harvey F. 2008, Molecular Cell Biology, W.H.Freeman & Company, 973pp.
7. Gerald Karp, 2009, Cell and Molecular Biology, Wiley Publications, 832pp.
8. Peter, J.D. and I.M. Roitt,2011. Roitt's essential Immunology, Wiley – Blackwell, 12th edition, 546 pp.
9. Abdul K.appas, Andrew H.Lichtman, S.Pillai, 2011 Cellular and Molecular Immunology, Elsevier Publications, 592pp.
10. Pandian, T.J., 2011. Sex determination in fish, CRC Press London, 277pp.

SUPPLEMENTARY READING

1. Paul, W.E., 2013. Fundamental Immunology (1283 pp).
2. Gerald Karp. 2014. Cell Biology (783 pp).
3. Charles F. Wimpee, Tracie-Lynn Nadeau and Kenneth H. 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. William J. Wiebe1 And George B. Chapman, 1968. Variation In The Fine Structure Of A Marine Achromobacter and a Marine Pseudomonad Grown Under Selected Nutritional and Temperature Regimes. *Journal Of Bacteriology*. 1874-1886 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the microscopes- light, phase contrast and interference, darkfield, fluorescence, confocal electron 3TEM and SEM).
CO2:	To understand the principles of genetics, practical applications of genetics, hybridization of fishes and recent trends.
CO3:	To understand the normal and transformed cell lines as model genetic systems and advantages.
CO4:	To understand the non- specific immune response, Immunological factors- humoral and clotting.
CO5:	To understand the elements of Immunology, Antigen, antigenicity, epitopes and haptens.

Course Outcomes

At the end of the course, the student will be able to

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 19MBOC 104 – MARINE MICROBIOLOGY

Credits: 3
Hours: 3

Learning Objective (LO):
LO1: To learn about the occurrence, distribution, structure and biology of marine bacteria.
LO2: To learn about the occurrence, distribution, structure and biology of marine cyanobacteria.
LO3: To learn about the occurrence, distribution, structure and biology of actionmycetes
LO4: To learn about the occurrence, distribution, structure and biology of marine fungi.
LO5: To learn about the occurrence, distribution, structure and biology of marine viruses.

Unit I - Ecology of marine bacteria

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit II - Ecology of marine cyanobacteria

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit III - Ecology of marine actinomycetes

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit IV - Ecology of marine fungi

Occurrence and distribution, structure and biology, ecological role, economic significance.

Unit V - Ecology of marine viruses

Occurrence and distribution, structure and biology, ecological role, economic significance.

Practical

1. Preparation of Media
2. Estimation of bacterial population from marine samples
3. Pure culture techniques
   - Phase streaking
   - Continuous streaking
   - 'T' streaking
   - Radial streaking
4. Identification of unknown bacteria
   - Motility of bacteria – hanging drop method/semisolid medium
   - Gram's staining
   - IMViC
   - Triple sugar iron agar
   - Starch hydrolysis
   - Casein hydrolysis
   - Carbohydrate utilization test
5. Isolation of cyanobacteria
6. Identification of cyanobacteria - morphological
7. Isolation of actinomycetes
8. Identification of actinomycetes – morphological
9. Isolation of fungi from marine samples
10. Identification of fungi – morphological
11. Isolation of bacteriophages
12. One step growth of bacteriophages
13. Preparation of bacteriophage stocks
14. Titration of bacteriophages
15. Purification of phage

TEXT BOOKS

1. Lederberg, H., 1992. Encyclopedia of Microbiology, Vol.1-4., Academic Press,NY. 1154 pp.
2. Dube, H.C., 1994. A Textbook of Fungi, Bacteria and Viruses, Vikas Publishing House,India 240 pp.
3. Mckane, L.and J.Kandel, 1996. Microbiology, Essentials and Applications. McGraw Hill Inc., New York, 843 pp.
4. Austin B. an D.A. Austin, 1996 Bacterial Fish Pathogens- Diseases of Farmed and Wild Fish, Springer Praxis Publishing, 457 pp.

5. Stickney, B.R., 2000. Encyclopedia of Aquaculture. John Wiley & 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. Microbial ecology of the oceans John Wiley & sons US 593pp.

SUPPLEMENTARY READING

1. Kim S.K., 2013. Marine Microbiology: Bioacive Compounds And Biotechnological Applications (549 pp).
2. Thatoi, H., R.R. Mishra, B.C. Behra, 2018. Mangrove Microorganisms: Biodiversity And Biotechnology (173 pp).
3. Paul R. Jensen, Ryan Dwight, And William Fenical, 1991. Distribution of Actinomycetes in Near-Shore Tropical Marine Sediments. *Applied and Environmental Microbiology*. 1102-1108 pp.
4. Kui Hong, An-Hui Gao, Qing-Yi Xie, Hao Gao, Ling Zhuang, Hai-Peng Lin, 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.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the occurrence, distribution, structure and biology of marine bacteria.
CO2:	To understand the occurrence, distribution, structure and biology of marine cyanobacteria.
CO3:	To understand the occurrence, distribution, structure and biology of actionmycetes.
CO4:	To understand the occurrence, distribution, structure and biology of marine fungi.
CO5:	To understand the occurrence, distribution, structure and biology of marine viruses

Outcome Mapping

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 19MBOC 105 – PHYSIOLOGY AND BIOCHEMISTRY

Credits: 4
Hours: 4

Learning Objective (LO):

LO1: To learn the physiology of feeding, feeding mechanism, passage of food, digestive enzymes and their role with food habits.

LO2: To learn about physiology of rhythms- circadian, tidal and lunar rhythms in marine and estuarine animals.

LO3: To learn about the physiology of nervous system- autonomic nervous system in elasmobranchs and bony fishes.

LO4: To learn about the major biomolecules – classification- carbohydrates, proteins, amino acids, lipids and fatty acids.

LO5: To learn the Metobolism of carbohydrates, amino acids and biosynthesis of nucleic acids.

UNIT 1 – Physiology of Feeding and Respiration

Physiology of feeding, feeding mechanisms, passage of food, digestive enzymes and their role with food habits. Respiratory structures and functions – Accessory respiratory organs, swim/air bladders, factors affecting respiration, structure and function of blood pigments, role of transport of O_2 and CO_2.

UNIT 2 – Osmoregulation and Biorhythms

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.

UNIT 3 – Nervous and Endocrine systems

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.

UNIT 4 – 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.

UNIT 5 – Metabolism and Biosynthesis

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. Chromatophore change due to light and dark adaptations in intertidal crabs.
2. Effect of hydrogen ion concentration on amylase activity of the crystalline style from bivalve.
3. Effect of temperature – the rate of particle transport in bivalves
4. Effect of salinity on respiration of fish/bivalve
5. Effect of salinity on osmotic concentration (osmoregulation) of fish.
6. Display of Neuroendocrine organs in a crustacean.
7. Estimation of total protein, carbohydrates, lipids, moisture content, calorific valve and ash content.
8. Separation of phospholipid using thin layer chromatography.
9. Separation of free and bound amino acids using paper chromatography.

TEXT BOOKS

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 and Physiology 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. The Biology of Crustacea vol. 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 and M.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.

SUPPLEMENTARY READING

1. Voet, D., J.Voet And C.W. Pratt, 2013. Principles Of Biochemistry (1077 pp).
2. George Hadwin. 2017. Fish Endocrinology (310 pp).
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 tolerance in marine ectothermic animals: pre-adaptation through lifestyle and ontogeny? *Biogeosciences*, 6, 2313–2331 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the physiology of feeding and feeding mechanism of marine organisms.
CO2:	To understand the physiology of biological rhythms of marine animals.
CO3:	To understand the physiology of nervous system in marine bony fishes and elasmobranchs.
CO4:	To understand the bioactive molecules and its importance from marine organisms.
CO5:	To understand the metabolisms of carbohydrates, amino acids and nucleic acid synthesis.

Outcome Mapping

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-I 19MBOP 107 – Practical – I (Covering MBOC 101, 102 & 105)

Credits: 3

Hours: 6

Semester-I 19MBOP 108 – Practical – II (Covering MBOC 103 & 104)

Credits: 2

Hours: 4

Semester-II **19MBOC 201 – PHYSICAL OCEANOGRAPHY**

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To learn the history of Oceanography, origin of Oceans and bottom topography.
LO2: To learn about heat budget of the oceans, sea level rise and global warming.
LO3: To learn about currents, waves and tides in the ocean.
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**.**

UNIT I - Introduction to Oceanography

History of Oceanography, Origin of Oceans, bottom topography, abyssal hills and plains, submarine canyons & oceanic trenches, underwater volcanoes.

UNIT II - Physical Properties of sea water

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

UNIT III – Dynamics of the ocean

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 – tide generating forces and theories, types of tides, tidal effects in coastal areas. Utilization of Wave / tide energy

UNIT IV- Estuaries

Origin and classification of estuaries, estuarine circulation, estuarine zonation, lagoons.

UNIT V - Marine sediments

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.

Satellite Oceanography

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

Practical

1. Determination of density of liquids using specific gravity bottle.
2. Measurement of salinity of seawater by refractometer
3. Determination of salinity of seawater by conductivity
4. Determination of salinity of seawater by salinometer
5. Relationship between salinity and density
6. Relationship between salinity and viscosity
7. Determination of surface tension by capillary method
8. Relationship between salinity and surface tension
9. Determination of viscosity by ostwald viscometer
10. Determination of turbidity using turbidity meter,
11. Water sampling Devices:
    a) Mayer's Water Sampler
    b) Knudsen Water sampler
    c) Nansen Water sampler
    d) Universal Water sampler
    e) Horizontal Water sampler
    f) Bacteriological Water sampler

12. Sediment sampling Devices
    a) Ekman's Dredge
    b) Petersen grab
    c) Mud snapper
    d) Vertical Gravity Corer
    e) Ooze Sucker
13. Temperature and depth measuring devices
    f) Towing Surface Thermometer
    g) Six's Maximum and Minimum Thermometer
    h) Reversing Thermometer
    i) Bathythermograph
    j) Fortin's Barometer
14. Light measuring devices
    a) Secchi Disc
    b) Lux Meter
15. Current measuring devices
    a) Watt's Current Meter
    b) Direct Reading Current Meter
16. Depth measuring devices
17. Wave and Tide recorder

TEXT BOOKS

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. and J.V. Thiruvathakal, 1976. Elements of Oceanography. 2nd edition, W.B. Saunders, Philadelphia, 346 pp.

3. Neshyba, S. 1987. Oceanography: perspectives on a fluid earth. John Wiley & Sons, New York, 506 pp.
4. Gross, G. 1993. Oceanography: A view of the earth 3sixth edition). Prentice – Hall Inc., New Jersey, 446 pp.
5. Pickard, G.L. and W.J. Emery, 1995. Descriptive Physical Oceanography – an Introduction (fifth edition). Pergamon Press, London, 520 pp.
6. Stowe, K., 1996. Exploring Ocean Science. John Wiley Sons Inc, NewYork 426 pp.
7. Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction To The World's Oceans. Wm. C. Brown Publishers,UK. 528 pp.
8. Harold V.Thurman, 2004. Introductory Oceanography. 10th edition, Prentice Hall Inc, New Jersey, 624 pp.
9. Genny Anderson, 2009. Tools of the Oceanography: Sampling equipments, measuring equipment, online marine science; Santa Barbara, California, USA.

SUPPLEMENTARY READINGS:

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.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the history of Oceanography, origin of Oceans.
CO2:	To understand the heat budget of the oceans, sea level rise and global warming.
CO3:	To understand the sea water currents, waves and tides.
CO4:	To understand the origin and classification of estuaries and lagoons.
CO5:	To understand the origin and physical properties of sediments.

Outcome Mapping

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 **19MBOC 202 – CHEMICAL OCEANOGRAPHY**

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To learn about the origin of ocean salts, physical and chemical properties of water.
LO2: To learn the concept of chlorinity and salinity of seawater.
LO3: To understand the origin, importance and distribution of dissolved gases- Carbon dioxide, oxygen, nitrogen.
LO4: To learn about the dissolved and particulate organic matter, sources and composition.
LO5: To learn about the inorganic plant nutrients, origin and role in the fertility of the sea.

UNIT 1 - Introduction to marine chemistry

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

UNIT 2 - Chemical composition of seawater

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.

Concept of chlorinity and salinity of seawater – methods of measurement – desalination. Marine corrosion.

UNIT 3 - Dissolved gases

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

UNIT 4 - Organic matter

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

UNIT 5 - Nutrients

Inorganic plant nutrients, origin, role in the fertility of the sea.

Kinds of nitrogen, phosphorus and silicate in the sea, analytical methods, distribution and cycling, N:P ratio and significance.

Mineral wealth of the sea – salts, glauconite, petroleum, phosphorite, manganese nodules, potential and economics of extraction.

Practical

Titrimetric Procedures

1. Salinity
2. Alkalinity
3. Dissolved oxygen
4. Calcium and Magnesium

Colorimetric Procedures of pollutants

5. Bromide, fluoride and iodide
6. Nitrite
7. Nitrate
8. Inorganic phosphate
9. Hydrogen Sulphide
10. Ammonia
11. Organic nitrogen
12. Silicate 3Reactive)
13. Total dissolved phosphorus

TEXT BOOKS

1. Riley, J.P. and R. Chester, 1971. Introduction to Marine Chemistry. Academic Press, 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.P and G. Skirrow, 1975 – 1984. Chemical Oceanography, Vols. 1 to 8. Academic Press, London, 606 pp.
4. Blackburn, T.H and J. Sorensen (Eds.), 1988. Nitrogen Cycling in Coastal Marine Environments, John Wiley & Sons. New York, 338pp.
5. Fergusson, J.E., 1990. The Heavy Elements: Chemistry, Environmental Impact and Health Effects. Pergamon Press,London 612 pp.

6. Pilson, M.E.Q., 1990. An Introduction to the Chemistry of the Sea. Prentice Hall, New Jersey, 680 pp.
7. Baretta – Bekker, J.G., E.K. Duursma and B.R. Kuipers (Eds.), 1992. Encyclopedia of Marine Sciences. Springer - Verlag. Berlin Heidelberg, New York, London, 311 pp.
8. Fernando, Olivia J, 1999. Sea Water Properties and Dynamics, Dhanesh Publications, Thanjavur.
9. Ghosh, A.K. and R. Mukhopadhyay, 1999. Mineral Wealth of the Ocean. Oxford and 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.

SUPPLEMENTARY READINGS:

1. K. Friis, A. Kortzinger, and D. W. R. Wallace, 2003. The salinity normalization of marine inorganic carbon chemistry data. *Geophysical Research Letters.*

2. Paula G. Coble, 2007. Marine Optical Biogeochemistry: The Chemistry of Ocean Color. *Chem. Rev.* 402–418 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the origin of ocean salts, physical and chemical properties of water.
CO2:	To understand the concept of chlorinity and salinity of seawater.
CO3:	To understand the origin, importance and distribution of dissolved gases.
CO4:	To understand the dissolved and particulate organic matter.
CO5:	To understand the inorganic plant nutrients.

Outcome Mapping

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 **19MBOC 203 – BIOLOGICAL OCEANOGRAPHY**

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To learn the sea as a biological environment.

LO2: To learn the methods of collection of phytoplankton and zooplankton, estimation of standing crop.

LO3: To learn about the primary and secondary productions and methods of estimation of primary production.

LO4: To learn about seaweeds – occurrence and distribution in India; Seagrasses- morphological and anatomical adaptations, their ecological role.

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

UNIT 1 – Marine Biocycle

Sea as a biological environment Plankton - classification of plankton based on size, mode of life and habitat.

UNIT 2 – 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.

Adaptations of plankton through structural (Weight, increase of surface area for flotation) and physiological (specific gravity, water content, fat content, mono and divalent ions, and gas vacuoles) mechanisms.

UNIT 3 - Organic production

Primary and secondary productions, methods of estimation of primary production, factors affecting primary production, spatial and temporal differences in primary and secondary productions, red tide phenomenon its causes and effects.

UNIT 4 – Seaweeds and Seagrasses

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

Seagrasses – morphological and anatomical adaptations, their ecological role.

UNIT 5 – Mangroves, salt marshes and sand dunes

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. and halophytes 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. Field collection – submission of herbarium sheets.

TEXT BOOKS

1. Wimpenny, R.S., 1966. Plankton of the Sea. Feber and Feber Limited, London, 426 pp.
2. Raymont, J.E.G., 1973. Plankton and Productivity in the Oceans. Oxford Pergamon Press, London, 660pp.
3. Chapman, V.J., 1976. Mangrove Vegetation. J. Gramer, Berlin, 292 pp.
4. Chapman, V.J. and D.J. Chapman, 1980. Seaweeds and Their Uses. 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. Marine Biology – An Ecological Approach.. Addison wesley Edu. Pub. Inc,London, 516 pp.
8. Kinne, O., 2004. Marine Ecology: Comprehensive integrated treatise on life in oceans and coastal waters, Wiley-interscience, New York Volume 1 -5 (1970 – 1984).
9. Miller, C.B.2004. Biological Oceanography Wiley-Blackwell US 402pp.
10. Kathiresan, K and S.Z. Qasim, 2005. Biodiversity of Mangrove Ecosystems. Hindustan Lever Limited, India,251 pp.
11. Jeffrey S.Levinton, 2008. Marine Biology: Function, Biodiversity, Ecology, 3rd ed.oxford university press ,USA 640pp.

SUPPLEMENTARY READINGS:

1. Hurd, C.L., Et Al.,2014. Seaweed Ecology And Physiology (551 pp).
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, Cyril Marchand, Irving Mendelssohn, Nibedita Mukherjee and Sydne Record, 2014. Ecological role and services of tropical mangrove ecosystems: a reassessment. *A Journal of Macroecology*. 726-743 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the biological environment of sea.
CO2:	To understand the collection methods of phytoplankton and zooplankton.
CO3:	To understand the primary and secondary productions and its involvements.
CO4:	To understand the distribution and occurrence of seaweeds and seagrass.
CO5:	To understand the mangroves, salt marshes and sand dunes.

Outcome Mapping

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 **19MBOC 204 – COASTAL AQUACULTURE**

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To know the importance of coastal aquaculture, global scenario and its present status in India.

LO2: To learn about selection of site: topography, water availability and supply, soil conditions.

LO3: To lean the criteria for choosing cultivable species- fish, crustaceans, mollusks and seaweeds.

LO4: To learn about the natural seed resources- distribution, abundance and methods of collection and segregation.

LO5: To learn about the culture practices- traditional, extensive, semi intensive, intensive system, monoculture and polyculture.

UNIT I - Introduction to coastal aquaculture

Overview – Importance of Coastal aquaculture, global scenario, present status in India - prospects and scope.

UNIT II - Brackishwater farms

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

UNIT III - Biology of important cultivable species

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.

UNIT IV – Seed resource survey and Seed & Feed production

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. Formulation of feed – conventional and non-conventional ingredients, additives, feed attractants, formulation protocol.

UNIT V – Culture systems and their management

Culture practices – traditional, extensive, semi – intensive and intensive systems, monoculture and polyculture, raceways, cages, pens, raft and racks.

Culture system management: Pond preparation –production and economics.

Water quality management, Health management: Control of predators, parasites and diseases.

. Disease diagnosis: Concepts - ELISA, Western blotting: DNA based diagnosis of diseases – fish vaccines.

Practical

1. Field trip to coastal aquaculture farms, hatcheries, raceways and Rack & Raft and procuring plants and Submission of Report
2. Spat collection techniques
3. Dissection of reproductive systems of fish and shrimp.
4. Identification of eggs, larvae, seeds, and juveniles of cultivable species.
5. Seed collection techniques – velon screen, Throw net, other scoop nets
6. Induced breeding and maturation techniques in fishes.
7. Identification of cultivable species of crustanceans, molluscs, finfishes and seaweeds.
8. Identification of live feed (Microalgae, rotifers, copepods and *Artemia*).
9. Western blotting
10. PCR Demonstration
11. Types of diseases – Observation
12. Identification of different larval stages in shrimps
13. Fabrication of Rack & Raft (floating and fixed), rope culture and spat collectors (rens).

TEXT BOOKS

1. Pillay, T.V.R., 1990. Aquaculture – Principles and Practices. Fishing News Books.575pp.
2. Samuel Paulraj, 1994. Shrimp Farming Techniques: Problems and Solutions. Palani pub.
3. Stickney, 1995. Introduction to Aquaculture. John Wiley & Sons, New York.
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. and R. L. Herman, 1997. Text Book of Fish Disease. Narendra Pub, 302 pp.
6. John E. Bardach, 1997. Sustainable Aquaculture. John Wiley & Sons, New York.
7. James, W. Meade, 1998. Aquaculture Management, CBS pub., New Delhi.

8. Robert R. Stickney (ed.), 2000. Encyclopedia of Aquaculture. John Wiley and Sons, 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.and H. Nithin, 2007. Mariculture of Mussels in India. Manual of CMFRI, Cochin.

SUPPLEMENTARY READINGS:

1. Lingaraj Patro, 2015. Fisheries And Aquaculture (473 pp).
2. George, N. And N.S. Charan, 2016. Fish Farming (243 pp).
3. J H Primavera, 2008. Socio-economic impacts of shrimp culture. Aquaculture Research. 815-827 pp.
4. Xie Biao and YuKaijin, 2007. Shrimp farming in China: Operating characteristics, environmental impact and perspectives. Ocean and Coastal management. 538-550 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the importance of coastal aquaculture.
CO2:	To understand the site selections and soil conditions.
CO3:	To understand the cultivable fin and shell fishes.
CO4:	To understand the natural seed resources and availability.
CO5:	To understand the various culture practices.

Outcome Mapping

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 **19MBOC 205 – FISHERIES SCIENCE AND STATISTICS**

Credits: 4
Hours: 4

Learning Objective (LO):

LO1: To learn about the general morphology and outline classification of fishes and identification 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: To learn about sampling techniques- biometry of fish- collection and analysis of biological data.

UNIT I – Ecobiology of fishes

General morphology and outline of classification of fishes – major groups of fishes of the 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, methods to determine spawning, biotic and abiotic factors affecting spawning in fishes. Food and feeding, fecundity and GSI

UNIT II - Population dynamics

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

UNIT III – Methods of Fishery Survey

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

UNIT IV – Crafts and Gears

Principal methods of exploitation of sea fishes – indigenous and modern gears and crafts. Principal methods of fish preservation and processing in India – types of fish spoilage, causative factors. Marketing and economics.

UNIT V – Statistics in fisheries

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. Identification of common fin and shell fishes of Parangipettai waters.
2. Dissection of 9^{th} and 10^{th} cranial nerves of teleost fishes
3. Food and feeding habits of fishes through Gut content analysis and Digestive system in 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. Study of reproductive system of teleost fishes
6. Fecundity estimation and ova – diameter studies, GSI values
7. Life history stages of fishes: eggs and larvae.
8. Morphometric and meristic data of fishes population
9. Collection of cost of different fishes (primary and secondary)and pattern of marketing
10. Economics of fishing of trawler.
11. Growth determination using scales: vertebrates & otoliths
12. Morphometric and meristic characters of a teleost fish
13. Dissection and display of inner ear in a fish, Weberian apparatus in a cat fish
14. Dissection and display of swim bladder of fishes
15. Observation on fish parasites
16. Visits to ice factory and nearby fish processing Units.
17. Methods of sampling and Data collection
18. Calculation of Mean, Mode, Standard Deviation, Standard Error, Co-efficient, Variation
19. Calculation of correlation of co-efficiency & ANNOVA

TEXT BOOKS

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. Fishery Biology and Aquaculture. Leo Pathippagam, 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 Text Book of Fish, Fisheries and Technology, II ED. Narendra Publishing House, Delhi, India, 396 pp.
6. Srivastava , C.B.L., 1999. Fish Biology. Narendra Publishing House, Delhi (India), 304 pp.
7. Mohan Joseph, M and A.A.Jayaprakash, 2003. Status of Exploited Marine fishery 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.

SUPPLEMENTARY READINGS:

1. Singh, R.K., 2013. Fishery Resources (256 pp).
2. Giriappa, S., 2015. Role Of Fisheries In Rural Development (178 pp).
3. Ray Hilborn, 2011. Determination of Fish Movement Patterns from Tag Recoveries using Maximum Likelihood Estimators. *Canadian Journal of Fisheries and Aquatic Sciences*. 635-643 pp.
4. Pierre Petitgas, Adriaan D. Rijnsdorp, Mark Dickey-Collas, Georg H. Engelhard, Myron A. Peck, John K. Pinnegar, Ken Drinkwater, Martin Huret and Richard D. M. Nash, 2012. Impacts of climate change on the complex life cycles of fish. *Fisheries Oceanography*. 121-139 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand themorphology and outline classification of fishes.
CO2:	To understand the fundamental principles of population dynamics.
CO3:	To understand the marine fisheries of India and their survey methods.
CO4:	To understand the exploitation methods of marine fishes
CO5:	To understand the sampling techniques and biometry of marine fishes.

Outcome Mapping

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-II 19MBOP 206 – Practical – III (Covering MBOC 201 & 202)

Credits: 3

Hours: 6

Semester-II 19MBOP 207 – Practical – IV (Covering MBOC 203 & 204)

Credits: 3

Hours: 6

Semester-II 19MBOP 208 – Practical – V (Covering MBOC 205)

Credit: 1

Hours: 2

Semester-III **19MBOC 301 – MARINE ECOLOGY AND ZOOGEOGRAPHY**

Credits: 4
Hours: 4

Learning Objective (LO):

LO1: To study about marine environment, ecological factors- light, temperature, salinity, pressure. Marine zoogeography.

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

LO3: To learn about group attributes, population density variation, age structure sex ratio population growth.

LO4: To learn about the structure composition and stratification, diversity and stability and concept of niche.

LO5: To know the importance of biodiversity, assessment techniques and threats to marine biodiversity.

UNIT 1 – Classification of Marine Environment

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

UNIT 2- Marine ecosystem

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.

UNIT 3 - Population ecology

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,

UNIT 4- Community ecology

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).

UNIT 5- Marine biodiversity

Definition and importance, biodiversity assessment techniques, threats to marine biodiversity, over-exploitation, physical alteration, pollution, alien species. Biosecurity.

Practical

1. Population analysis of *Cerithidea cingulata, Uca sp.:* Quardrate and Transect method
2. Sex ratio of *Uca* sp.
3. Collection and identification of animal and community studies of different environments
    i) Pelagic
    ii) Muddy shore
    iii) Sandy shore
    iv) Rocky shore
    v) Interstitial
    vi) Oyster bed community
    vii) Phytal faunal community (Seaweed and seagrass).
    viii) Fouling and boring organisms
    ix) Assessment of biodiversity of any one of the above communities
4. Preparation of a Field Report.

TEXT BOOKS

1. Briggs, J.C., 1974. Marine Zoogeography. McGraw Hill, New York, 475 pp.
2. Nair, N.B. and D.M. Thampy, 1980. A Text Book of Marine Ecology. The Macmillan Co. India Ltd., New Delhi, 352 pp.
3. Odum, E.P. 1987. Basic Ecology. Saunders College Publication, Philadelphia, 895 pp.
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: Patterns and Processes. Cambridge university press, London 449 pp.
7. Barnes, R.S.K. and R.N. Hughes. 1999. An Introduction to Marine Ecology (Third edition), Blackwell Science, US.286 pp.
8. Townsend C.R., J.L. Harper and M. Begon. 2000. Essentials of Ecology. Blackwell Science, US. 552 pp.
9. Nybakken, J.W. 2001. Marine Biology – An ecological approach (Fourth edition) 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.

SUPPLEMENTARY READINGS:

1. Hajime Kayanne, 2016. Coral Reef Science (101 pp).
2. Salvanes, A.G.V., et al.,2018. Marine Ecological Field Methods (218 pp).
3. John S. Gray (1997). Marine biodiversity: patterns, threats and conservation needs. Biodiversity and Conservation 6, 153-175.
4. John J. Stachowicz, Robert B. Whitlatch and Richard W. Osman, 1999. Species Diversity and Invasion Resistance in a Marine Ecosystem. *Science.* 1577-1579 pp.

Course Outcomes

At the end of the course, the student will be able to:

CO1:	To understand the marine environment and ecological factors
CO2:	To understand the coastal ecosystem structure and function.
CO3:	To understand the group attributes, population density variation.
CO4:	To understand the structure composition and stratification.
CO5:	To understand the importance of biodiversity and its assessment.

Outcome Mapping

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 19MBOC 302– MARINE BIOTECHNOLOGY, BIOINFORMATICS AND INSTRUMENTATION

Credits:4
Hours:4

Learning Objective (LO):

LO1: To learn about the tools and techniques: PCR, blotting, Gene probes and Gene sequencing.
LO2: To study about the bioactive compounds from marine environment: isolation, purification and identification of compounds.
LO3: To learn about recombinant protein production in microbes.
LO4: To study about the history of Bioinformatics, Database searching (BLAST).
LO5: To learn about Chromatography and Spectroscopy.

UNIT1 – Tools and Techniques

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.

UNIT 2- Marine Pharmacology

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

UNIT 3 – Marine Microbial Technology

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)

UNIT 4 - Bioinformatics

Definition and history

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 function prediction of proteins.

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

UNIT 5 – Chromatography & Spectroscopy

Chromatography: Principles of paper, thin layer, ion-exchange, affinity, gas-liquid chromatography and HPLC.

Spectroscopy: Absorption and emission principles, UV-vis, Atomic absorption and emission spectrophotometers, fluorescence spectrophotometer, NMR and Mass spectrometer.

Practical

1. Extraction and quantification of Nucleic acid and proteins
2. Electrophoresis – Agarose gel electrophoresis and PAGE.
3. Blotting (Southern & Western) & PCR
4. Tissue culture techniques- Preparation and maintenance of plant and animal cell lines
5. Chromatography
    a. Paper
    b. Column
    c. TLC
6. Basic principles and application of atomic absorption Spectrophotometer, Inductively coupled plasma spectrophotometer, GC, FT-IR, GC-MS, HPLC, UV-Visible spectrophotometer and fluorescence spectrophotometer
7. BLAST search for similar nucleotide sequences
8. Protein secondary structure, tertiary structure and Motifs prediction.
9. Visualizing 3D structure of macromolecules using RASMOL.
10. Isolation and extraction of bioactive compounds from marine organisms

TEXT BOOKS

1. Alan T.Bull, Geoffrer Holt and Malcolm D.Lilly, 1983. Biotechnology International Trends and Perspectives. Oxford & IBH Publishing Co., New York, 84 pp.
2. Ewing, G.W., 1988. Instrumental methods of chemical analysis, McGraw-Hill Book Company, NY.538 pp.
3. Skoog, D.A. and J.J. Leary, 1992. Principles of instrument analysis. 4th edition. Saunders College publishers, Philadelphia, 700 pp.
4. David H. Attaway and R. Oskar, 1993. Marine Biotechnology. 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.

SUPPLEMENTARY READINGS:

1. Brown, T.A., 2016. Gene Cloning And Dna Analysis: An Introduction (353 pp).
2. Sabamurthy, K. And Ashutosh Kar, 2016. Pharmaceutical Biotechnology: Fundamental and Applications (497 pp).
3. Patricia Rodriguez Tome, Peter J. Stoehr, Graham N. Cameron and 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.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the biotechnological tools and techniques.
CO2:	To understand the bioactive compounds from marine organisms.
CO3:	To understand the recombinant protein production.
CO4:	To understand the concept of bioinformatics and its applications.
CO5:	To understand the importance of chromatography and spectroscopy.

Outcome Mapping

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 19MBOC 303 – POLLUTION AND TOXICOLOGY

Credits: 4
Hours: 4

Learning Objective (LO):

LO1: To study about marine pollution, GESAMP, major pollutants- source and transport path.
LO2: To study about sewage, industrial, agricultural and domestic discharge and composition of sewage.
LO3: To study about heavy metal pollution- sources, distribution and fate
LO4: To study about oil pollution- composition, sources and fate of spilled oil.
LO5: To study about thermal pollution- sources and waste heat disposal.

UNIT 1 - Basics in Marine Pollution

Marine Pollution – Definition of GESAMP - Major pollutants – sources, transport path, 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.

UNIT 2 - Major Pollutants – Sewage and Detergent

Sewage; industrial, agricultural and domestic discharges. Composition of Sewage - impact on marine environment, treatment methods (primary, secondary and tertiary).

Detergents – composition – eutrophication and ecological significance, interference in the sewage treatment system.

UNIT 3 – Major pollutants – Heavy metals & 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 impacts in the marine environment – endocrine disrupters.

UNIT 4 – Major Pollutants - Oil

Oil pollution – composition, sources and fate of spilled oil, biodegradation, biological impact of oil on marine organisms.

Unit 5 – Minor Pollutants

Thermal pollution – sources – waste heat disposal, uses of waste heat, role of biocides (Chlorine), ecological impacts.

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

Plastics and litter – impact of mining and dredging operations in the marine environment.

Practical

Analysis and estimation of critical pollutants.

a) Estimation of Ammonia (NH3)
b) Estimation of Hydrogen sulphide (H_2S)
c) Estimation of BOD
d) Estimation of COD
e) Pesticide residues in sea water and selected beeverages
f) Petroleum hydrocarbons in sea water
g) Heavy metals (Cu, Cd, Pb, Hg) in seawater, sediments & animal tissues
h) Preparation of solution (Standard, Normal, Molar) for toxicological studies
i) Methodology of toxicity testing – acute and chronic tests (demonstration)
j) Use of LC_{50} values – sublethal effects of critical pollutants on fish and shellfish.

TEXT BOOKS

1. Johnston, R. (Ed.), 1976. Marine Pollution. Academic Press, London, 729 pp.
2. Pantin, S.A., 1982. Pollution and the Biological Resources of the Oceans. Butterworth Scientific Co., London.
3. Clark, R.B., 1992. Marine Pollution. 3rd Edition. Clavendon Press, Oxford,UK 172 pp.
4. Carl J.Sindermann, 1995. Ocean Pollution: Effects on Living Resources and Humans 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. Michael J.Kennish, 1997. Pollution Impacts on Marine Biotic Communities (310pp) 7/77, CRC press, New York.
7. David J.Hoffman, Barnett A. Rattner, G.Allen Burton, Jr.Johan Caims, Jr., 1997. Hand Book of Ecotoxicology (755pp) – 7/018. Lewis publishers, Tokyo.
8. Trivedi, R.K.2001. Aquatic Toxicology and Toxicology (239 pp) 7/157 – ABD publishers, Jaipur
9. Michael C. Newman, Morris H. Roberts, Jr. Robert C. Hale, 2001. Coastal and Estuarine Risk assessment (347pp) 07/125 Lewis publishers, New York
10. Yasunori Murakami, Kei Nakayama, shin – Kitamura., 2008. Biological Response to Chemical pollutants. Terra pub, Tokyo, 372 pp.

SUPPLEMENTARY READINGS:

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. ShinsukeTanabe[a]Maricar SPrudente[b]SupawatKan-atireklap[c]AnnamalaiSubramanian, 2000. Mussel watch: marine pollution monitoring of butyltins and organochlorines in coastal waters of Thailand, Philippines and India. *Ocean & Coastal Management*. 819-839 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the marine pollution and pollutants.
CO2:	To understand the various pollutants and their impact on coastal environment.
CO3:	To understand the heavy metal pollution and its impact.
CO4:	To understand the oil pollutions and its impact.
CO5:	To understand the thermal pollution and its impact on marine environment.

Outcome Mapping

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 19MBOC 304 – Ocean Management

Credits: 4
Hours:4

Learning Objective (LO):

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

LO2: To study biodiversity from a global and national view.

LO3: To study about the importance of coastal zone and coastal developmental activities such as mariculture.

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

LO5: To study RS and GIS Technologies- application in marine resources exploration.

Unit – I: **Law of the sea**

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).

Role of International, National Agencies and Organizations in Ocean Management

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: **Developmental Activities and Impacts**

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: **Coastal zone management issues**

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: **Remote sensing & 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.

TEXT BOOKS

1. Ross, D.A., 1980. Opportunities and Uses of the Ocean. Springer Verlag, New York
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 & Protecting Marine 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 for the Oceans – A Report to the Independent World 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. An Introduction to the World's Oceans. 6th Edition. McGraw Hill Companies, 528 pp.

SUPPLEMENTARY READINGS:

1. Vats, C.K., 2015. Coastal Zone Management (312 pp).
2. Robert G. Healy & Jeffrey A. Zinn, 1985. Environment and Development Conflicts in Coastal Zone Management, Journal of the American Planning Association, 51:3, 299-311 pp.
3. Farid Dahdouh-Guebas, 2002. The use of Remote sensing and GIS in the sustainable management of Tropical Coastal Ecosystems. *Environment, Development and Sustainability.*93–112 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the law of the sea and the Geneva Convention.
CO2:	To view the biodiversity in global and national level.
CO3:	To understand the importance of coastal zone and coastal developmental activities.
CO4:	To understand the RS and GIS Technologies.
CO5:	To understand the RS and GIS Technologies- application in marine resources exploration.

Outcome Mapping

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-III 19MBOP 307 – Practical – VI (Covering MBOC 301 & 302)

Credits: 3

Hours: 6

Semester-III 19MBOP 308 – Practical – VII (Covering MBOC 303)

Credit: 1

Hours: 2

Semester-IV **19MBOC 401 – Ornamental Fish Culture & Aquarium Keeping**

Credits: 4
Hours: 4

Learning Objective (LO):

LO1: To study the freshwater and marine aquarium status, ornamental fish trade, aquarium fishes and collection strategies.
LO2: To understand the culturing practices and hatchery techniques and live feed culture.
LO3: To study the designing of fish tanks, aeration, filtration and lighting setup in the aquarium tanks.
LO4: To study the setting of aquarium tanks and decoration in indoor and outdoor aquarium tanks.
LO5: To study the preparation of pellet feed and disease management in the aquarium fishes.

Unit I **Introduction**
Fresh and marine water aquaria - Global and Indian status of aquarium keeping - Ornamental fish trade Advantages and benefits - Criteria for choosing aquarium fishes - Common aquarium fishes - collection techniques.

Unit II **Culture and hatchery production**
Breeding of fresh and marine water ornamental fishes - collection - conditioning - brood stock development -feeding - spawning - larval rearing - Live feeds - stock and mass culture.

Unit III **Designing, Aeration, filtration and lightings**
In door and outdoor aquaria - Tank designs - fabrication - choosing of right tank - Air pumps - filters biofilters - devices - aquarium lights - water quality maintenance - test kits.

Unit IV **Setting up of aquarium**

Fresh and marine water set up - aquascaping - adding decorative materials - aquarium plants - community aquarium.
Unit V **Health management**
Basic diets - pellet feeds - formulation - Diseases - diagnosis and health management - treatment methods Colour enhancement - induced breeding

REFERENCE BOOKS

1. Dawes,J., 1995. Live bearing Fishes (A guide to their Aquarium care, Biology and Classification). 1st Edition, Cassell Pvt., London . 240 pp.
2. Adey, W. H. and K. Loveland, 1998. Dynamic Aquaria Building Living Ecosystems. 2nd Edition, Academic Press,US. 498 pp.
3. Axelrod, H. R and L. P.Schultz, 2000. Hand book of trophical aquarium Fishes. 1st Edition, orinocobooks - Sheffield SYK United Kingdom. 717 pp.
4. Grist, C., D. Mills and A. Caine, 2002, he Practical Encyclopedia of the Marine Aquarium. Interpet Publishing-US. 208 pp.
5. Kuravamveli, S. J., 2002. The Aquarium Handbook. 1st Edition, Amity Aquatech pvt. Ltd Cochin. 256 pp.
6. Hemdal J.F., 2003.Aquarium Fish Breeding. 1st Edition, Barron's Educational Series-US. 176 pp.
7. Stephen Spotte,2005 . Marine Aquarium Keeping the Science Animals and Art. Las Vegas, 1st Edition, NV, USA. 171 pp.
8. Sundararaj, V and J.M. Sathish, 2005. Tropical marine aquarium. 1st Edition, Yegam publications, Chennai. 160 pp.
9. Fletcher A.M., 2006. unusual aquarium Fishes. 1st Edition, Mishawaka, IN, USA. 397 pp.
10. Yoan, N., 2011. Live-Bearing Aquarium Fish. 1st Edition, Miss Press,US. 52 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand freshwater and marine aquarium status, ornamental fish trade, aquarium fishes and collection strategies.
CO2:	To view the culturing practices and hatchery techniques and live feed culture.
CO3:	To understand the designing of fish tanks, aeration, filtration and lighting setup in the aquarium tanks.
CO4:	To understand the setting of aquarium tanks and decoration in indoor and outdoor aquarium tanks.
CO5:	To understand the preparation of pellet feed and disease management in the aquarium fishes.

Outcome Mapping

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

19MBOP 404 - Project work

Semester-IV **Credits: 8**

Department Electives (DE)

19 MBOE 305Disaster Management

Credits: 3
Hours: 3

Learning Objective (LO):

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: To study the disaster management strategies during the pre-disaster and post disaster periods.
LO4: To study the response and recovery systems at national, state and local, coordination between different agencies.
LO5: To study the Prevalent national and global management practices in disaster managements.

UNIT I

Basic concepts - Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India.

UNIT II

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.

UNIT III

Disaster Management strategies - Management strategies: pre-disaster, during disaster and post-disaster. Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures.

UNIT IV

Response and recovery systems - During disaster: response and recovery systems at national, state and local, coordination between different agencies,

international best practices. Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation.

UNIT V

Agencies in disaster management - Prevalent national and global management practices in disaster management. Agencies involved in monitoring and early warnings at district, state, national and global levels. Sea safety and health.

REFERENCE BOOKS

1. Harsh K. Gupta ,2003. Disater Managemnet, University press, 152pp.
2. Damon P. Coppola, 2015. Introduction to International Disaster Management, Butterworth-Heinemann, 760pp.
3. I.Sundar T.Sezhiyan,2007. Disaster Management, Sarup & Sons, 182pp.
4. Jack Pinkowski, 2008. Disaster Management Handbook, CRC Press, 624pp.
5. Rajiv Sinha, Rasik Ravindra, 2012. Earth System Processes and Disaster Management, Springer Science & Business Media, 244pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand coastal hazards, risk assessment and disaster management strategies in India
CO2:	To understand the types of hazards in fisheries sector and other impact of natural disasters and assessment.
CO3:	To understand the disaster management strategies during the pre-disaster and post disaster periods.
CO4:	To understand the response and recovery systems at national, state and local, coordination between different agencies
CO5:	To understand the Prevalent national and global management practices in disaster managements.

Outcome Mapping

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**

19MBOE306 Marine Food Technology

Credits: 3
Hours: 3

Learning Objetives (LO):

LO1: To study the preservation and processing methods and type of preservatives in fish processing.
LO2: To study the packing methods, utilization and preparation of fishery by-products.
LO3: To study the spoilage of seafood caused by mircroorganisms and their controll measures.
LO4: To study the qulality management of fishery products and certification approaches for commerical applications.
LO5: To study the product development and nutrition promotion, consumer studies qualitative and quantitative research methods.

Unit I

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.

Unit II

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.

Unit III

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.

Unit IV

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.

Unit V

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

REFERENCE BOOKS

1. Kreuzer, R., 1974. Fishery Products, FAO Fishing News (Books) Ltd., England, 280 pp.
2. Anon, 1979. Handling, Processing and Marketing of Tropical Fish. Tropical Products Institute, London.
3. Miller, M.D., 1990. Ciguatera Seafood Toxins, CRC Press New York.
4. Carison, V.R. and R.H. Graves, 1996. Aseptic Processing and Packing of Food : A Food 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. Post Harvest Technology of Fish and Fishery Products, Daya Publishing House, New Delhi, 440 pp.
7. Wilson, C.L., S. Droby, 2000. Microbial food contamination, CRC Press, New York.
8. Balachandran,K.K, 2001. Post Harvest Technology of fish and fish products, Daya Publishing House, New Delhi 440 pp.
9. Novak, J.S., G.M. Sapres and V.K. Juneja, 2002. Microbial safety of minimally processed foods, CRC Press, New York.
10. Weidenborner, M., 2003. Encyclopedia of food mycotoxins, Springer Verlag,USA.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the preservation and processing methods and type of preservatives in fish processing.
CO2:	To understand the packing methods, utilization and preparation of fishery by-products.
CO3:	To understand the spoilage of seafood caused by mircroorganisms and their controll measures.
CO4:	To understand the qulality management of fishery products and certification approaches for commerical applications.
CO5:	To understand the product development and nutrition promotion, consumer studies qualitative and quantitative research methods

Outcome Mapping

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

19MBOE402 Microbial Technology

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To study the isolation and screening of industrial important microbes and strain development for commercial agents.

LO2: To study the principles of bioprocess technology and optimization for product development.

LO3: To study the recombinant protein product in microbes and their issues in commercial production.

LO4: To study the bioremediation of microbes and their significant role in toxic waste removal and ore leaching.

LO5: To study the application of microbes in food and healthcare industries, food processing and food preservation approaches.

Unit I

Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins.

Unit II

Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products.

Unit III

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)

Unit IV

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

Unit V

Microbial application in food and healthcare industries; Food processing and food preservation; Antibiotics and enzymes of pharmaceutical use.

REFERENCE BOOKS

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.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the isolation and screening of industrial important microbes and strain development for commercial agents.
CO2:	To understand the principles of bioprocess technology and optimization for product development
CO3:	To understand the recombinant protein product in microbes and their issues in commercial production.
CO4:	To understand the bioremediation of microbes and their significant role in toxic waste removal and ore leaching.
CO5:	To understand the application of microbes in food and healthcare industries, food

	processing and food preservation approaches.

Outcome Mapping

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

19MBOE403 REMOTE SENSING & GIS

Credits: 3
Hours: 3

Learning Objective (LO):
LO1: To study the principles and applications of remote sensing and types of sensors and their applications.
LO2: To study the application of remote sensing in the assessment of marine flora and ocean colour monitoring.
LO3: To study the principles and applications of GIS and mapping of marine resources by using the GIS tools.

LO4: To study the spatial Analysis, Integration and modelling strategies and concept of Web GIS.
LO5: To study the marine resources exploration, Mapping and Marine Resources information 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, Microwave Remote Sensing and Hyper-spectral Remote Sensing. Satellites and sensors: 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, interactive graphic 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 Web GIS.

Unit V

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.

REFERENCE BOOKS

1. Ramachandran, S., 2000. Marine remote sensing applications. Institute for Ocean Management, Anna University.
2. Lillesand, T.M. and R.W. Kefer, 2000. Remote Sensing and 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, Tsehaie Woldai, 2001. Principals of Remote Sensing An Introductory Text Box, 2nd edition, 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. 2nd edition. , ITC Educational Textbook Series.
6. Yeqiao, Wang, 2009. Remote Sensing of coastal environments. Taylor & Francis, CRC Press, 457 pp.
7. Michael Kennedy, 2009. Introducing Geographic Information systems with ArcGIS: A workbook approach to learning GIS, 2nd edition, Wiley publications, 624 pp.
8. Pinde Fu and Jiulin Sun, 2010. Web GIS: Principles and Applications. ESRI, 312 pp.
9. Christian Harder, 2011. Understanding GIS: An ArcGIS Project workbook, ESRI, 378 pp.
10. Vasilis, D.Valavanis, 2011. Marine Geographical Information Systems: Theory and Applications (Advances in Geographic Information Science), Springer, 500 pp.

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the principles and applications of remote sensing and types of sensors and their applications.
CO2:	To understand the application of remote sensing in the assessment of marine flora and ocean colour monitoring.
CO3:	To understand the principles and applications of GIS and mapping of marine resources by using the GIS tools.
CO4:	To understand the spatial Analysis, Integration and modelling strategies and concept of Web GIS.
CO5:	To understand marine resources exploration, Mapping and Marine Resources information System.

Outcome Mapping

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

Inter Departmental Electives (IDE)

19 MBOE 106 Soft Skill Development

Credits: 3
Hours: 3

Learning Objective (LO):

LO1: To learn the communications skills, interpreting the verbal and non verbal cues.

LO2: To learn the presentation skills, preparation and participation of group discussions.

LO3: To learn the technical writing skills, preparation of abstract, results, discussion and data interpretation.

LO4: To learn the applications of computer skills browsing search engines Hidden Web and its importance in scientific research.

Unit I: Introduction to Soft Skills

What are soft skills?-What are hard skills?-Importance of soft skills-Importance of knowing yourself-SWOT Analysis and its benefits-Developing positive attitude-Power of positive attitude-overcoming negative attitude.

Unit II: Effective Communication

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.

Unit III: Business Communication

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

Unit IV: Employability Skills

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

Unit V: Professional Skills

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

Supplementary Reading:

- Alex K. *Soft Skills* New Delhi:S.Chand & Co., 2016
- Ghosh,B.N *Managing Soft Skills for Personality Development* New Delhi: Tata McGraw Hill, 2012
- Krishna Mohan and Meera Banarji. *Developing Communication Skills.* New Delhi: Macmillan,2009
- NeeraJain and Shoma Mukherji. *Effective Business Communication.* New Delhi: Tata McGraw Hill,2012
- Rao, M.S. *Soft Skills-Enhancing Employability*: *Connecting Campus with Corporate*. New Delhi: LK Publishing House, 2011
- Rizwi, Ashraf M. *Effective Technical Communication.* New Delhi : Tata McGraw Hill,2010

Course Outcomes

At the end of the course, the student will be able to

CO1:	To understand the communications skills.
CO2:	To understand the presentation skills, preparation and participation methods.
CO3:	To understand the technical writing skills.
CO4:	To understand the applications of computer and browsing search engines.

Outcome Mapping

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-PO MAPPING SCORES

Courses Impact	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
Total Score	198	198	129	132	207	192	126