KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಸೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂರ್ತಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

Faculty of Science and Technology

Two Years PG Programme

M.Sc. Marine Biology

Programme Structure and Syllabus

As per NEP-2020

With Effect from 2024-25

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE:

1. One credit is equal to 1 hour of theory teaching per week.
2. One credit is equal to 2 hours of practical teaching per week.
3. One credit is equal to 15 hours of theory syllabus per semester (1 Unit is equal to 15 Hours)
4. One credit is equal to 30 hours of practical syllabus per semester (1 credit practical is equal to 2 hours/ week)

A. Workload for theory subjects:

1. There shall be 16 hrs./week workload for Assistant Professor
2. There shall be 14 hrs./week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs./week workload relaxation for Guiding Ph.D. students

B. Workload for practical subjects:

1. There shall be 20 hrs./week workload for Assistant Professor
2. There shall be 18 hrs./week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs./week workload relaxation for Guiding Ph.D. students

C. Workload for practical batches:

1. A batch of 10-12 students shall have 1 teacher

D. Workload for Project:

1. Students for projects/internships shall be preferably guided by permanent faculty for at least 10 students by sharing equally among the permanent faculty. If remained excess shall be allotted to other teachers on roll on a temporary basis.
2. If there are no permanent faculty, the students shall be distributed among the temporary teachers on roll.
3. There shall be a maximum of 4 hrs./week workload for guiding the students for project work irrespective of number of students.

II. ALLOTMENT OF SPECIALIZATION:

While allotting specialization in the 3rd and 4th semesters, a minimum of 10 students shall have to select the specialization.

III. **ATTENDANCE:** 75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one of the courses (papers) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on the notice board.

IV. CREDIT AND MARKS EQUIVALENCE:

1. Generally, 20% weightage for Formative assessment and 80% weightage for Summative assessment.
2. Up to 2 credits equal to 50 marks (10 marks for Formative assessment and 40 marks for summative assessment).
3. 3-4 credits equal to 100 marks (20 marks for Formative assessment and 80 marks for summative assessment).
4. 5-6 credits equal to 150 marks (30 marks for Formative assessment and 120 marks for summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8^{th} week and 10 marks for the 14^{th} week of every semester.

V. **Conduct of Examination:**

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision for improvement. A special Formative assessment examination shall be conducted for a student who represents University/State/National level sports, cultural and other events if a schedule is overlapping.

2. 80 marks summative theory examination shall be conducted for 3 hrs. and 40 marks for 1.5 hrs.

3. 80/40 marks Formative/Summative Practical examination shall be conducted for 4 hrs.

4. There shall be a single examiner for both even and odd semesters Formative Practical examination.

5. There shall be a single examiner for the odd semester Summative Practical examination and two examiners for the even semester Summative Practical examination; one from internal and the other shall be an external examiner.

VI. Assessment:

1. **Theory papers:** There shall be a single valuation for odd semester theory papers preferably internal examiner and a double valuation for even semesters; one from the internal and the other shall be external examiner.
2. **Project/Internship assessment**

A) **For 100 marks Project/Internship assessment (Wherever applicable):**

i. **Formative Assessment**: Project/Internship assessment carrying 20 marks out of 100 marks. The candidate has to submit two Progress Reports; each carries 10 Marks. i.e. 10 x 2= 20 marks.

ii. **Summative Assessment**: Project/Internship assessment carrying 80 marks out of 100 marks

a. Project Report : 35
b. Presentation : 25
c. Viva-voce : 20

B) **For 150 marks Project/Internship assessment (Wherever applicable):**

i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks. The candidate has to submit two Progress Reports; each carries 15 Marks. i.e. 15 x 2= 30 marks.

ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks
a. Project Report : 60
b. Presentation : 35
c. Viva-voce : 25

VII. Passing criteria:

1. There shall be no minimum passing marks for Formative assessment.
2. The candidate has to score a minimum 40% in the summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, a candidate has to score a minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every course.

VIII. DECLARATION OF RESULT:

1. Candidate has to score 40% as above in all the courses to pass the semester-end examination to declare pass.
2. **Percentage and Grading:** The result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under
3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade (GP)	Percentage (%)	Grade (GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0
46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

A grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0

4. A student's level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.
5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of the sum of the number of Credit Grade Points scored from all the courses (subject) of a given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).
6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for the 4-semester programme.

   CGPA= $(Credit_1 \times SGPA_1) + (Credit_2 \times SGPA_2) + (Credit_3 \times SGPA_3) + (Credit_4 \times SGPA_4)$ / Total credits of programme (sum of credits of 4 semesters).
7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with a CGPA score after rounding off to the second decimal and class distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the programme (Degree)	Class obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and the final Grade Card shall have semester-wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.
9. There shall be Revaluation/Challenge valuations provisions as per the prevailing rules and regulations.
10. Marks obtained from the OEC shall not be considered for the award of CASH PRIZE/RANK/ GOLD MEDAL.

i. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME:

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X. ANY OTHER TERMS AND CONDITIONS:

Apart from the above, the prevailing rules and regulations are valid for any other matters which are not addressed in this regard.

Department of Studies in Marine Biology
Karnatak University Post Graduate Centre, Karwar.

Vision

The center strives to lead its stakeholders towards excellence in the field of Marine Science by setting higher standards of learning and teaching with relevant and meaningful curriculum towards innovative research and pursuit of virtuous careers and taking steps towards good governance by helping to develop informed leadership for a knowledge society.

Mission

To produce competent scientific manpower for exploration, utilization, and rational management of resources of the Oceans around us by introducing curricula that are contemporary, competitive, skillful, and relevant, which would enable students to be creative, knowledgeable, and entrepreneurial. To provide a healthy atmosphere for the students, scholars, and teaching faculty to engage in globally competitive, multi-disciplinary research, consultancy, and extension work and mold them to be leaders in their endeavors. To adopt e-governance, to make academics an administration responsive and efficient.

Goals

To be an epitome of excellence for various domains of academics and innovation to fulfill the vision and mission of our institution. To offer a pioneering ecosystem for innovation, development of entrepreneurship, and establishment of start-ups. To develop active industrial and institutional collaborations.

Programme offered - M.Sc. Marine Biology – 2 Years duration

Centre	Eligibility Criteria	Intake For Normal Fees	Intake For Enhanced Fees
Karnatak University Post-Graduate Center, Karwar	Life Science/B.Sc. Degree in Botany/ Zoology/ Biotechnology/Fisheries/Fish & Industrial Fisheries / as one of the Optional Subjects with a Minimum 45% marks and 40% marks for SC/ST/Cat-I candidates.	16	09

Programme Outcomes:

Understandings of Ocean functions and phenomena and associated biology. Interdisciplinary nature of science, ecosystem, competency of research, entrepreneurship and integrity skills.

Career opportunities

Students with M.Sc. in Marine Biology can appear for competitive examinations like UGC/CSIR/SLET etc., for undertaking research fellowships or lectures in degree colleges or Universities as professionals on all India bases. They can also prepare for UPSC and KPSC and Indian Council of Agriculture Research competitive examinations to work as scientific personnel in R&D Institutions and Industries. Students get opportunities to set up their entrepreneurship related to aquaculture, processing and marketing. Large numbers of students use the course as a platform to go abroad and pursue higher studies and research.

Genesis and Brief History

The Earth is often called as the "blue planet" due to its vast oceans, which cover about 71% of the planet's surface. These oceans are home to an astonishing 80% of all life forms. They play a crucial role in regulating the Earth's climate and atmosphere, producing oxygen, and providing food and economic opportunities for humanity. The ocean represents the last frontier where mankind can find essential resources. However, the relentless exploitation of both living and non-living resources, coupled with pollution and the climate crisis, underscores the urgent need to maintain a healthy ocean ecosystem. Human activities such as overfishing, habitat destruction, and the release of pollutants have severely impacted marine life and habitats. Climate change has further exacerbated these issues, leading to ocean acidification, rising sea levels, and more frequent and severe weather events.

Preserving ocean health is not just about environmental stewardship; it's also about safeguarding our planet's future and well-being. Efforts to mitigate these impacts include implementing sustainable fishing practices, establishing marine protected areas, reducing plastic waste, and scientifically investing in renewable energy sources to lower carbon emissions. Understanding and protecting our oceans is essential for ensuring that they continue to provide their invaluable benefits to both current and future generations. Considering the importance of ocean studies and the jurisdiction of the university, the Marine Biology teaching program was introduced at Kodibag, Karwar, Uttara Kannada District, approximately 180 km from the main campus. The campus journey began in 1968 with the setup of a marine zoology laboratory as specialization to Zoology course, designed to study various marine biotopes such as coastal waters, estuaries, backwaters, and mangrove wetlands.

Recognizing the need for a comprehensive M.Sc. curriculum, a Marine Biology degree was introduced in 1975 with the establishment of a postgraduate center. Since then, the department has actively engaged in teaching, research, and extension activities, catering to the needs of Society, Government and the Industrial sector.

The center has completed and continues to work on scientific research projects funded by various national agencies, including UGC, DBT, MoE, INCOIS, and BRNS.

The department has conferred 81 Ph.D., and 18 M.Phill., degrees to date. The campus is well equipped with an analytical and wet laboratory, a museum featuring a unique whale skeleton, a library, and hostel facilities for both boys and girls.

The excellent training given to the students helps them to be placed in National and International laboratories, undergraduate and post-graduate colleges in the country and abroad, fisheries departments, private industries and self-entrepreneurship.

Extension activity:

In 1998, the Department established the Fishermen Guidance Bureau, an extension wing designed to address government, industrial, and societal needs through consultancy projects in marine biology.

Contact details (Phone (Chairman), email, weblink)

Department Phone: 08382-225372;200350

M: 9449125950; 9663037103

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Karnatak University, Dharwad

M.Sc., in Marine Biology
Effective from **2024-25**

Sem.	Type of Course	Theory/ Practical	Course Code	Course Title	Instruction hour/week	Total hours/ Sem.	Duration of Exam	Marks			Credits
								Formative	Summative	Total	
I	DSC-1	Theory	**A1MBK001T**	**Biosystematics & Biology of Non-Chordates**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-2	Practical	**A1MBK002P**	**PRACTICAL – Biosystematics & Biology of Non-Chordates**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-3	Theory	**A1MBK003T**	**Genetics and Molecular Cell Biology**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-4	Practical	**A1MBK004P**	**PRACTICAL - Genetics and Molecular Cell Biology**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-5	Theory	**A1MBK005T**	**Oceanography**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-6	Practical	**A1MBK006P**	**PRACTICAL – Oceanography**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-7	Theory	**A1MBK007T**	**Marine Ecology and Pollution**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-8	Practical	**A1MBK008P**	**PRACTICAL – Marine Ecology and Pollution**	04	56 hrs.	04 hrs.	10	40	50	02
								120	**480**	**600**	**24**
II	DSC-9	Theory	**A2MBK001T**	**Biology of Chordata, Reproductive & Developmental Biology**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-10	Practical	**A2MBK002P**	**PRACTICAL - Biology of Chordata, Reproductive & Developmental Biology**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-11	Theory	**A2MBK003T**	**Environmental Science and Planktonology**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-12	Practical	**A2MBK004P**	**PRACTICAL – Environmental Science and Planktonology**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-13	Theory	**A2MBK005T**	**Aquaculture**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-14	Practical	**A2MBK006P**	**PRACTICALS – Aquaculture**	04	56 hrs.	04 hrs.	10	40	50	02
	OEC – 1	Theory	**A2MBK027T**	**Open Elective Course**	04	60 hrs.	03 hrs.	20	80	100	04
				Total				**110**	**440**	**550**	**22**

Sem.	Type of course	Theory/ Practical	Course Code	Course Title	Instruction hour/week	Total hours/ Sem.	Duration of exam	Marks			Credits
								Formative	Summative	Total	
wIII	DSC-15	Theory	**A3MBK001T**	**Fishery Harvest and Post-Harvest Technology**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-16	Practical	**A3MBK002P**	**PRACTICALS – Fishery Harvest and Post-Harvest Technology**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-17	Theory	**A3MBK003T**	**Animal Physiology, Endocrinology & Biochemistry**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-18	Practical	**A3MBK004P**	**PRACTICALS- Animal Physiology, Endocrinology & Biochemistry**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-19	Theory	**A3MBK005T**	**Mariculture**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-20	Practical	**A3MBK006P**	**PRACTICALS- Mariculture**	04	56 hrs.	04 hrs.	10	40	50	02
	OEC – 2	Theory	**A3MBK027T**	**Open Elective Course**	04	60 hrs.	03 hrs.	20	80	100	04
								110	**440**	**550**	**22**
IV	DSC-21	Theory	**A4MBK001T**	**Fishery Resources and Management**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-22	Practical	**A4MBK002P**	**PRACTICALS- Fishery Resources and Management**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-23	Theory	**A4MBK003T**	**Marine Biotechnology**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-24	Practical	**A4MBK004P**	**PRACTICALS- Marine Biotechnology**	04	56 hrs.	04 hrs.	10	40	50	02
	DSC-25	Theory	**A4MBK005T**	**Fishery Economics and Management**	04	60 hrs.	03 hrs.	20	80	100	04
	DSC-26	Practical	**A4MBK006P**	**PRACTICALS- Fishery Economics and Management**	04	56 hrs.	04 hrs.	10	40	50	02
	Project – 1	Practical	**A4MBK007P**	**Project**				30	120	150	06
								115	**485**	**600**	**24**
				Total				**455**	**1845**	**2300**	**92**

Marine Biology – Syllabus

I-SEMESTER

Course Title: Biosystematics & Biology of Non-Chordates (Theory)

Course Code: A1MBK001T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Conceptualize the scope and procedure involved in the taxonomy and evaluation of biodiversity indices.
CO 2	Learn animal kingdom classification and distinguish between the major invertebrate phyla.
CO 3	Learn the concept, characteristics and classifications of minor phyla. Also understands structural modifications among invertebrates.
CO 4	Understand the comparative accounts of physiological systems of invertebrates.

Unit	Content	Hours
Unit I	**Principles of Taxonomy** History and Scope of Taxonomy. Species concept. Theories of biological classification. Taxonomic hierarchy. Taxonomic procedures – Collections, Preservations Curetting, the process of identification. The central theme of the International Code of Zoological Nomenclature. Modern trends in taxonomy. Evaluation of biodiversity indices: Shannon diversity index, Dominance index, Similarity and dissimilarity index, Association index.	**15 hrs.**
Unit II	**Diversity of Animals- Modern Classification** Outline Classification of Animal Kingdom. Major characteristics and basis of modern classification. Diversity of animals. Concept of major and minor phylum. Outline classification of invertebrates. Major characteristics of invertebrates. Classification of major phylum - Protozoa, Porifera, Cnidaria, Platyhelminthes, Annelida, Arthropoda, Mollusca and Echinodermata.	**15 hrs.**

Unit III	**Minor phyla** General organization and systematic position of minor phyla - Ctenophora, Nemertinea, Chaetognatha, Entoprocta, Rotifera, Kinorhyncha, Phoronida, Brachiopoda**.** **Structural Adaptations and Digestive System in Invertebrates** Structural modifications and adaptations for locomotion, food and feeding. Structural variations in the digestive system.	**15 hrs.**
Unit IV	**Respiratory, Circulatory, Nervous and Reproductive System** Structure involved in respiration. respiratory pigments. Evolution of respiratory strategies. Role of body fluid. Types of circulations. Circulatory mechanism. Excretory organs and excretion. Cephalization. Development and evolution of a nervous system. Sense organs. Reproductive patterns. Reproduction and metamorphosis. Larvae and their evolutionary significance.	**15 hrs.**

Reference Books:

1. Barnes R. D. (1968). Invertebrate Zoology. W.B. Saunders Co., Philadelphia, London and Toronto,
2. Barnes & Robert D. (1987). Invertebrate Zoology, Publisher: Saunders College Publishing, Philadelphia.
3. Clark R. B. (1964). Dynamics in Metazoan Evolution. Oxford: Clarendon Press.
4. Clark R. B. (1981). Locomotion and the phylogeny of the Metazoa. *Italian Journal of Zoology*, *48*(1), 11-28.
5. Frank A. & Brown (1950). Selected Invertebrate Types, Publisher: Jhon Wiley & Sons, New York.
6. Hyman L. H. (1967). The Invertebrates, Vol. I – VI, Mc Graw-Hill, N. Y.
7. Hyman Libbie Henrietta, 1888-1969 (2023). https://archive.org › details invertebrates0004hyma.
8. Kotpal R. L (2005). Modern textbook of Zoology Invertebrates (Animal Diversity -1), Rastogi Publications. Pp-795-831.
9. Kotpal R. L. (2013). MINOR PHYLA, https://www.amazon.in › MINOR-PHYLA-ZOOLOGY-
10. Kotpal R. L. (2015-16). Minor Phyla – Rastogi Publication ISBN:978-935078-025-1.
11. Kotpal R. L. (2016-17). 11th edition, Modern textbook of Zoology Invertebrates (Animal Diversity - 1). Rastogi Publication, Meerut; ISBN 978-93-5078-040-4
12. Mayer E. (1963). *Animal species and evolution*. Harvard University Press.
13. Rastogi V. B. (2015). Invertebrates Zoology. Publisher: Kedar Nath Ram Nath.
14. Sherman I. W. (1970). *The invertebrates: function and form*. Pearson Education India.
15. Verma P. S. (2015). A manual of practical zoology, Invertebrates, Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110055.
16. Yadav V., Yadav, P., Varshney, V. K., Varshney, V. C. (2015). Textbook of Practical Zoology- Publisher: Kedar Nath Ram Nath Meerut.

- **Online websites:**

- WoRMS - World Register of Marine Species
- www.Sealifebase.se
- www.iczn.org
- Bio search Marine biodiversity database of India

Course Title: Biosystematics & Biology of Non-Chordates (Practical)

Course Code: A1MBK002P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire hands-on skills in animal taxonomy and learn the dissection of invertebrate represents and the techniques of mounting invertebrate organs.

Unit	**Content**	**Hours**
	1. Concept of taxonomy, taxonomic characters, the procedure in animal taxonomy, Principles and applications, rules of the International Code of Zoological Nomenclature, and modern approaches to taxonomy. 2. Identification and systematic positions of Invertebrates (Major phylum). 3. Mounting – Spicules of sponges. 4. Mounting - Mouth parts and appendages of shrimp and crab. 5. Mounting - Nephridium and parapodium of Nereis. 6. Mounting - Radula of Gastropods. 7. Mounting - Pedicellaria and Aristotle's lantern of Sea Urchin 8. Dissections- Digestive, Nervous and Reproductive systems of Nereis, Shrimp, Crab, Perna, Oyster, Clams, Sepia. 9. Water vascular system of Starfish, 10. Study of larval stages of invertebrates and mountings. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Genetics and Molecular Cell Biology (Theory)

Course Code: A1MBK003T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Understand the concepts and phenomena and mechanisms of Genetics.
CO 2	Learn DNA structure, gene expression and mutations.
CO 3	Understand the concept of Ultrastructure of cells and its components, cell cycle and a detailed account of cancer biology.
CO 4	Conceptualize the theoretical knowledge of cell biology techniques and instrumentations.

Unit	Content	Hours
Unit I	**Mendelian genetics, Linkage and Crossing over** An overview of Mendelian Genetics. The phenomenon of dominance and its applications in animals. Mechanisms of dominance. Law of segregation. Law of independent assortment. Sutton's view on Linkage, Morgan's view on linkage. Chromosome theory of linkage, complete & incomplete linkage, significance of linkage. Types of crossing over. Somatic and germinal crossing over. Mechanism of crossing over. Synapsis. Kind of crossing over. Significance of crossing over. Sex-linked inheritance. Multiple alleles. Structure of Genes.	**15 hrs.**
Unit II	**Chemical Nature of Genetic Material** DNA structure and its replication. One gene one polypeptide concept. Genetic control of protein synthesis. Regulation of gene expression in prokaryotes and eukaryotes. Genetic engineering. Gene mutations. Chromosomal mutations. Practical application of mutation. Polyploidy in animals and their application. Hybridization of fishes. Recent trends and techniques in hybridization.	**15 hrs.**
Unit III	**Cell membrane, Cell Cycle and Cancer** Fluid mosaic model of the plasma membrane. Transport across bio-membrane - Passive transport, Active transport, Endocytosis and Exocytosis. Structure and functions of cell organelle. Bioenergetics. Protein import to mitochondria. Cell division- Amitosis, Mitosis and Meiosis. Cell cycle- phases of cell cycle and molecular events of cell cycle. Cytoskeleton- structure and role in cell architecture, Structure of cilium and flagellum. Cellular aging, Cell death mechanisms - necrosis and apoptosis. Cancer: Benign and Malignant tumors. Types of cancer- carcinomas, sarcomas, lymphomas, leukemias and mixed types. Properties of cancer cells, cancer treatment.	**15 hrs.**

Unit IV	**Techniques in Cell Biology.** Techniques in cell biology - Microscopy, Focal length, Angular aperture of lens and Resolving power of the microscope. Light microscopy. Phase-contrast microscope, Darkfield microscope, Fluorescence microscopy, Scanning Electron Microscope (SEM) and Scanning Transmission Electron Microscopy (STEM). Staining - Chemical basis of staining, simple staining and differential staining. Chromatography - Different phases of chromatography, Absorption chromatography, Thin layer chromatography and partition chromatography. Centrifugation- Differential, Gradient, Zonal centrifugation and Equilibrium density centrifugation. Electrophoresis- mechanism of electrophoresis.	**15 hrs.**

Reference Books:

1. Agarwal V. K. and Verma P. S. (1997). 1st edition, The *Concept of Genetics, Human Genetics and Eugenic* 03 255, pp-240.
2. Agarwal V.K. and Verma P. S. (1997). 1st edition, The *Concept of Molecular Biology* 03 255. Pp-160.
3. Berg P. (1991). *Reverse Genetics: Its origin and prospects Biotechnology* 9: 342-344.
4. De Robertis (1965). Cell Biology, W.B. Saunders Company, London.
5. Gupta P. K. (2004). *Biotechnology and Genomics*, Rastogi Publication Meerut, India, pp1-796
6. Gupta P. K. (2016-17). 1st edition, *Molecular Biology and Technology* and Textbooks for university students, Rastogi Publication Meerut, ISBN 978-93-5078-050-3.
7. Gupta P. K. (2016-17). 8th edition, *Cytology, Genetics and Evolution*, A textbook for undergraduate students, Rastogi Publication, Meerut, ISBN 978-93-5078-136-4
8. Gupta P. K. (2007). *Genetics*, Rastogi Publication, Meerut, India
9. Joshi. P. (2007). *Genetics Engineering and its Application*, Published by Agrobios, Jodhpur, ISBN 81-7754-197-8
10. Mari Muttu. R. (2008). *Microscopy and Microtecnicals* - MJP, Chennai
11. Priyadarshini A. and Pandey P. (2021). Molecular Biology Different Facets, Apple Academic Inc, pp – 318. ISBN-13 978 177 463 1362
12. Rastogi V. B (2016). Cell And Molecular Biology 5th edition 2018-19 Rastogi Publication Shivaji Road Meerut. India. ISBN 1397893 507 81548 pp-1192.
13. Satpathy G. C. (2001). *Developmental and Modern Biology*, Kalpaz, Delhi; ISBN 81-7835-053
14. Sharma N. S. (2005). 1st edition, *Molecular Structure of Genes and Chromosomes*, Published by International Scientific Publishing Academy, New Delhi, ISBN 81-8293-020-0
15. Singh B. D. (2022). Fundamentals of genetics MedTech science press scientific International Private Limited Ansari Road Daryaganj New Delhi. Pp-730, ISBN 13 9 7 8 9 3 9 3 1 6 8 3 6 8
16. Strickerburger W, Monore (2015). Genetics Pearson Education India ISBN 13 978 93325 55105.
17. Tandy Warnow (2019). Bioinformatics and Phylogenetics. Springer.
18. V. K. Verma and Verma P. S. (2005). Cell Biology. Genetics, Molecular Biology, Evolution and Ecology. Chand and Company. New Delhis.

Course Title: Genetics and Molecular Cell Biology (Practical)

Course Code: A1MBK004P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Learn to handle microscopes, and observe the ultra-structure of cell, its components and chromosomes. Learn histological techniques.

Unit	Content	Hours
	1. Introduction to Microscopes, handling of microscopes and its components. 2. Study of Prokaryotic and Eukaryotic cells 3. Preparation of fixatives, stains and other reagents 4. Microtomy- Preparation and mounting of histological slides using fish tissues. 5. Chromosome preparations and Cell cycle study 6. Onion root tips (Mitosis). 7. Testis / Rheo bud (Meiosis) 8. Study of Polytene chromosomes in Chironomus/ Drosophila larva. 9. Study of tissues- Temporary mounting of epithelial, nervous, muscular, connective and cartilage tissues. 10. Punnet squares – Mendelian Genetics – Mono and Dihybrid cross. 11. Introduction to Phylogenetics and constructions of phylogenetic tree. 12. Introduction to Bioinformatics and its application in Molecular taxonomy. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Oceanography (Theory)

Course Code: A1MBK005T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Conceptualize the ancient and modern oceanographic developments and have insight into national and international institutes.
CO 2	Understand the concepts of ocean basins, the origin of oceans, plate tectonics and the features of ocean basins and the marine sediments.
CO 3	Learn the physical properties of seawater, sea ice, ocean currents and ocean phenomena.
CO 4	Learn the chemical composition of seawater and its constituents and about various hydrological cycles.

Unit	Content	Hours
Unit I	**Introduction to Oceanography** History and various disciplines of oceanography — definitions, dimensions, limits, and explorations. Ancient and modern oceanographic expeditions. International and National Institutions of Oceanography. Recent developments and modern challenges in Oceanography science. Satellite oceanography and Remote sensing technology.	**15 hrs.**
Unit II	**Geological Oceanography** Origin of oceans, Continental drift and plate tectonics. General submarine topography & oceanographic features - Classification of seafloor. Origin and evolution of continental shelf, slope, ridges, trenches, and canyons. Topography of Antarctic & Southern Ocean, Arctic, Atlantic, Indian and Pacific oceans. Features of the Arabian Sea and the Bay of Bengal. Waves, tides and tsunamis. Marine Sediment – classification, constituents, distribution and significance of marine sediments. Mudflats, their formation and importance. Particulate suspended matter. Principles of bio-geochemistry.	**15 hrs.**
Unit III	**Physical Oceanography** Physical properties of seawater and sea ice. Freezing point and factors affecting freezing point of seawater. Distribution and significance of salinity, temperature, and density. Thermocline, Halocline, and Pycnocline. Heat budget of the ocean. T.S. diagram and water masses. General circulation and current patterns in the world's oceans: Atlantic, Pacific, Indian, and Southern Oceans jet currents. Indian Monsoon currents, Upwelling and sinking. Arabian Sea and Bay of Bengal currents. El-Nino and La-Nino phenomenon.	**15 hrs.**

Unit IV	**Chemical Oceanography** Chemical composition of seawater, Constancy of composition and factors influencing composition. Major and minor constituents. pH. Distribution of pH in the marine environment, redox potential, selected radioactive isotopes and stable isotopes organic compounds, dissolved gases, process regulating the composition. Trace metals and their biological role. Oxygen cycle - Sources, concentration, distribution and factors affecting the distribution of oxygen. Carbon cycle- sources, concentration, distribution and factors affecting the distribution of carbon dioxide. Nitrogen, Phosphorus and Silica cycle. Factors affecting the distribution of nutrient elements. Vertical distribution of nutrient elements in the world ocean.	**15 hrs.**

Reference Books:

1. Albert Defant (1961). *Physical Oceanography.* Volume II; Pergamon Press. California.
2. Allen E. Herbert, James R. Kramer (1980). *Nutrients in Natural waters*; A Wiley- Inter Science Publication
3. Dean F. Martin (1970). *Marine Chemistry.* Marcel Dekker, INC., New York
4. Diwan A. P and Arora D. K. (1995). *Oceanography Environment*, Anmol Publications, New Delhi
5. Gerhard Neumann and Willard J. Pierson (1994). *Principal of Physical Oceanography*; United States of America
6. Sverdrup H. U. (1961). The Oceans Their Physics, Chemistry, and Biology. Prentice Hall. NY.
7. Harold Barnes (1968). *Oceanography and Marine Biology*, Vol-1, The Marine Station, Millport, Scotland
8. Hawkins S. J., Allcock A. L., Bates A. E. (2019). Oceanography and Marine Biology. CRC Press.
9. Keen M. J. (1968). *An Introduction to Marine Geology*, Hazell Watson and Vincy Ltd, Great Britain
10. R. Davis, J. R. (1977). The principles of Oceanography. Addison-Wesley Publishing Company.
11. Wallace S. Broecker (1974). *Chemical Oceanography* by Harcourt Brace Jovanovich, Inc.; United States of America.
12. Werner Stumm and James J. Morgan (1970). Aquatic Chemistry, Wiley- Inter science; A Division of John Wiley and Sons, Inc- United States of America
13. Robert H. S. (2000). *An Introduction to Physical Oceanography*. A. M. University. Texas.

Course Title: Oceanography (Practical)

Course Code: A1MBK006P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire skills in the operations of oceanographic instruments, seawater collection and physio-chemical parameter analysis. Involve in field visits for the in-situ study of coastal ecology.

Unit	Content	Hours
	1. Study of general oceanographic instruments-Physical, chemical & biological study of water samples. 2. Estimation of the Salinity of seawater 3. Estimation of CO_2 in seawater. 4. Estimation of Dissolved oxygen in seawater. 5. Estimation of Calcium. Estimation of nutrients- Nitrates, Phosphates and Silicates. 6. Measurement of pH and temperature. 7. Measurement of light intensity and suspended load. 8. Sediment analysis- Sand, silt, clay and organic matter. 9. Measurements of wave parameters. 10. Beach profiling. Study of erosion and accretion. 11. Identification and classification of cloud types. 12. Operation of meteorological equipment. 13. Remote sensing and satellite oceanography. 14. Concept of tide table. High tide and low tide calculations. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Marine Ecology and Pollution (Theory)

Course Code: A1MBK007T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	The unit will enable students about fundamental ecological concepts, biotic interactions, and environmental factors influencing marine organisms.
CO 2	The unit will provide knowledge about the classification of the marine realm, various marine ecosystems, their unique characteristics, and the challenges posed by biofouling and invasive species.
CO 3	The topic will provide information on various types of pollution, their impacts on marine ecosystems, and strategies for prevention and mitigation, including global environmental issues and ecotoxicological principles
CO 4	The unit will enhance knowledge of Marine and Coastal Environmental Impact Assessment procedures and Coastal Zone Management Issues.

Unit	Content	Hours
Unit I	**Concepts of Ecology** Ecology and its concepts. Ecological factors – Abiotic and Biotic. Community structure. Ecological Succession. Ecosystem - Kinds of Ecosystem. Structure of Ecosystem. Productivity of Ecosystems. Biotic factors - Nutrition, competition, predator, prey-predator relationship. Lunar periodicity, biological clock. Liebig's law of the minimum. Shelford's Law of Tolerance. Animal associations- endemism, mutualism, commensalism, symbiosis and parasitism.	**15 hrs.**
Unit II	**Marine Ecology** Classification of the marine realm – Pelagic, neritic, epipelagic, mesopelagic, bathyal and abyssal. Between the tide – Intertidal and Rocky shore zonation, community structure and animal adaptations. Estuarine ecosystems. Coral reef ecosystem. Mangrove diversity, distributions and ecological adaptations. Deep sea adaptations. Marine food-web and trophic relationships. Concept and component of bio-fouling. Marine foulers and wood borers, and other invasive species. Anti-fouling measures.	**15 hrs.**
Unit III	**Pollution and Ecotoxicology** Types of pollution. Source of pollution. Marine pollution – Source of pollution. Oil pollution, Solid waste and plastic pollution, thermal pollution, nuclear hazard, anthropogenic and industrial pollution. Impact of mining and dredging. Pollution control, prevention and mitigating measures. Role of Central and State Pollution Control Board.	**15 hrs.**

	Bioaccumulation, biotransformation and biomagnification. Bioindicator organisms. Global warming and climate change. Ozone depletion. Acid rain and its impact. Ecotoxicology-types of toxicity, principles, dose-response and Bioassay.	
Unit IV	**Coastal Impact Assessment** Marine and coastal impact assessment. Coastal Regulatory Zone notification. Shoreline changes due to development. Coastal management issues - comparison between temperate and tropical countries - Integrated coastal zone management. Introduction to Environmental Impact Assessment (EIA). EIA notifications of the Government of India from time to time. Categorization of projects. EIA processes, Scoping and EIA methodologies, Procedure for reviewing Environmental impact analysis and statement.	**15 hrs.**

Reference Book:

1. Agarwal V.K and Verma P. S (1997). *Concept of Ecology, Environment Biology*, 03 257 1/e, pp-272.
2. Ananda Rao T and Suresh P. V (2002). Coastal Ecosystem of Karnataka State, India. Mangroves. Karnataka Association for Advancement of Sciences Bangalore.
3. Datta Munshi. J and Datta Munshi. J. S (1995). 1st edition, *Fundamentals of Freshwater Biology*, Narendra Publication, Delhi.
4. G. Karleskint & R Turner (2012). Introduction to Marine Biology. Unleash –Inc. ISBN: 978-1133364467.
5. Harrison R. M. (2015). Pollution- Causes, Effect and Control. RSC Publishing, Cambridge UK.
6. Kathiresan K, Bingham B. (2001). Biology of Mangroves and Mangrove Ecosystems, Advances in Marine Biology, 40;81-251.
7. Michael H & Peter C (2009). Marine Biology. Apex media. ISBN – 978-0073524160.
8. Selvam V. L, Gnanappazham, Naramuniyammal. M, Ravichandran K.K and Karunagaran V.M, (2002). Atlas of Mangrove Wetlands of India: Part 1 M.S Swaminathan Research Foundation.
9. Smith Nelson A (2013). Oil pollution and Marine Ecology. Pp-260. Verlag New York Inc ISBN 13:978 14757 60651
10. Venkataraman K, Rajkumar R, Satyanarayana C. H, Raghunathan C and Venkatraman C (2012). Marine Ecosystem and Marine Protected areas of India, Zoological Survey of India, Chennai, Kolkata. ISBN 978-81-8171-312-4.
11. Weis S. J. (2014). Physiological developmental and behavior effects of marine pollution. Springer publishers. Pp- 454. ISBN 139789 4007 957 85.

Course Title: Marine Ecology and Pollution (Practical)

Course Code: A1MBK008P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire hands-on training in ecotoxicological studies, and ecological adaptations. Estimating pollutants from marine habitats, coastal impact assessment procedures. Involve in field visits to study various marine ecosystems.

Unit	Content	Hours
	1. Collection and study of boring and fouling communities. 2. Ecological adaptations – Estuary, Rocky shore and Sandy shore. Pelagic and benthic adaptations. 3. Estimation of metals from water and sediment samples. 4. Preparation of stock solution for Ecotoxicological studies. 5. Basic requirement of aquatic toxicological studies. 6. Crustacean and fin fish bioassays. 7. Coastal Regulation Zone (CRZ), demarcations and map reading. CRZ proposals, requirements and submission procedures through case studies. 8. Environmental Impact Assessment (EIA), study requirement, categorization, study procedures and suggesting mitigating measures and management through case study. 9. Assessment of solid waste components along the coastal habitats—mangroves and intertidal region. Report preparation, Performa for solid waste management. 10. Visit intertidal regions- Rocky shores, Sandy shores, mud flats, mangrove forests and estuaries. (*New practical component may be added every year*)	**56 hrs.**

II – Semester

Course Title: Biology of Chordata, Reproductive & Developmental Biology (Theory)

Course Code: A2MBK001T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Conceptualize the origin of chordate, its classification and characteristics.
CO 2	Understand the classification of tetrapods and their adaptations
CO 3	Learn characteristics and classification of mammals with special reference to marine mammals, biology and adaptations.
CO 4	Learn the comparative anatomy and developmental biology of vertebrate represents

Unit	Content	Hours
Unit I	**Chordata - Protochordata, Cyclostomes and Pisces:** Origin of Chordata. Classification and general organization. Development, life cycle and affinities of Urochordata, Cephalochordata and Cyclostomata. Classification, External morphology, Evolution and adaptive radiation in fishes. Scales, Air-bladder and Sense organs in fishes. Age and growth in fishes, Food and feeding in fishes Reproduction in fishes, migration in fishes. Poisonous fishes.	**15 hrs.**
Unit II	**Amphibia, Reptiles, and Aves** General Characteristics and Classification of Amphibia. General account and adaptations. General Characteristics and Classification of Reptiles. Turtles and tortoises, Sea Turtle distribution, taxonomy and conservation in India. Sea turtle biology and adaptations. Sea snake and its biology. General characters and classification of Aves – marine birds, migration, aerial adaptations of birds. Importance of marine birds.	**15 hrs.**
Unit III	**Mammals and its Adaptations** General characters and classification of mammals – aquatic mammals, adaptations and evolution of Cetacea and Sirenia; Adaptations for life in the Sea. Cetaceans: Whales, Dolphins and Porpoises classification and biology. Sirenians: Manatees and Dugongs – Biology and Adaptations. Pinnipeds and Fissipeds: diversity, distribution and biology. Echolocation in Mammals.	**15 hrs.**
Unit IV	**Comparative Anatomy and Developmental Biology** Integuments and its derivatives in vertebrates. Evolution and Differentiations of aortic arches, heart, brain, respiratory, limbs, Kidney	**15 hrs.**

	and urinogenital systems**.** Sexual, asexual, parthenogenesis. Oviparity, viviparity and ovo-viviparity. Types of Regeneration. Structure and types of sperm and eggs. Sequence and events of fertilization, prevention of polyspermy. Introduction, Cleavage patterns, regulation and morphogenic movements. The fate of Germ layers, placenta in mammals. Differentiation of neural tube, anterior, posterior and dorsoventral axis, differentiations of erythrocytes, myogenesis.	

Reference Books:

1. Agarwal V. K and Verma P.S. (1997). Chordate Embryology, 10/e Rep. pp – 683.
2. Davis R. W., & Thomson D. H. (2019). Marine mammals. *Sensory Systems, Adaptations for an Aquatic Life; Springer: Berlin/Heidelberg, Germany*. 177-217.
3. Francis Day (1889). The Fishes of India. Vol I and II.
4. Gerosa G. & Aureggi M. (2001). Sea turtle handling guidebook for fishermen–teaching book. *UNEP/MAP RAC/SPA, Tunis, Tunisia*.
5. Gopi K. C. & Mishra S. S. (2015). Diversity of marine fish of India. In *Marine faunal diversity in India* (pp. 171-193). Academic Press.
6. Jordan E.L and Verma P.S. (2016). Chordate Zoology. 14th edit. ISBN-13: 978-8121916394 ISBN-10:8121916399.
7. Kotpal R. L (2016-17). Modern textbook of Zoology. 4th edition. Vertebrates (Animal Diversity 2) Rastogi Publication, ISBN978-93-5078-095-4
8. Lal S. S (2016-17). Practical Zoology. Rastogi Publication, Meerut, India
9. Munro I. S. R. (2000). *The marine and freshwater fishes of Ceylon*. Daya Books.
10. Ridgeway S. H., & Harrison, R. J. (Eds.). (1981). *Handbook of marine mammals*. Academic Press Incorporated.
11. Ridgway S. H., & Harrison, R. J. (Eds.). (1998). *Handbook of marine mammals: the second book of dolphins and the porpoises*. Elsevier.
12. Satoh N. (2016). *Chordate origins and evolution: the molecular evolutionary road to vertebrates.* Academic Press.
13. Schreiber E. A., & Burger J. (Eds.). (2001). *Biology of marine birds*. CRC press.
14. Spotila J. R. (2004). *Sea turtles: a complete guide to their biology, behavior, and conservation*. JHU Press.
15. Swalla B. J., & Xavier-Neto J. (2008). Chordate origins and evolution. *genesis*, *46*(11), 575-579.
16. Verma P. S and V.K (2000) Chordata Embryology, Developmental Biology of Non-Chordates and Chordates. Chand and Company Publication. ISBN 81-219-0261 4.
17. Verma P. S. (2010). *Chordate zoology*. Chand & Company. New Delhi.
18. Veena (2010). Understanding Marine Biology ISBN-13: 978-8183565424 ISBN-10:8183565425.
19. Young L., & Vander Werf E. (Eds.). (2022). *Conservation of marine birds*. Academic Press.

- **Online websites:**
- WoRMS - World Register of Marine Species
- www.Sealifebase.se
- Marine Species Identification Portal
- Bio search Marine biodiversity database of India
- http:/fishbase.se
- Marlin bird identification app.

Course Title: Biology of Chordata, Reproductive & Developmental Biology (Practical)

Course Code: A2MBK002P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire knowledge and skills in vertebrate classification, and dissection of fish. Study the marine mammals based on the charts and models. Visit the marine megafaunal stranding locations for in-situ study.

Unit	Content	Hours
	1. Identification and classification of Chordates. 2. Mounting – Placoid scale, Cycloid scale, Ctenoid scale. 3. Assessment of age and growth. 4. Mounting of Ampullae of Lorenzini in Shark 5. Study of development stages of fish and amphioxus. 6. Preparation of whole mount of embryo and larvae of fish. 7. Sea snake taxonomy and study of its adaptation. 8. Sea Turtle – classification and its taxonomy. 9. Classification of marine mammals. Study of the anatomy of Dolphins, Porpoises, Dugongs, and Whales based on scientific charts and models. 10. Dissection of eye muscles, Digestive, Circulatory, reproductive system, Brain, and cranial nerves of Sharks. 11. Study of the Circulatory system of bony fish. 12. Visit Sea turtle nesting sites, beach characteristics, and nest reproductive indices. Turtle conservation strategies. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Environmental Science and Planktonology (Theory)

Course Code: A2MBK003T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Understand the environmental concepts, ecological community, energy source and environmental issues.
CO 2	Learn concepts of biodiversity, threats, conservation and associated conservation acts and policies.
CO 3	Understand types and classifications, and geographical distributions of planktons.
CO 4	Learn the interrelationships of planktons, types of nektons and benthos.

Unit	Content	Hours
Unit I	**Environment and its Components** Structure and component of the environment – Atmosphere, Hydrosphere and Lithosphere. Biosphere – Organizational levels of biosphere. Population and community ecology. Food pyramids. Energy flow. Types of natural resources – Forest, Water, Mineral, Marine. Renewable and non-renewable resources. Growing energy needs. Use of alternate energy source. Conservation and management. Environmental education and awareness. Environmental institutes and governing bodies.	**15 hrs.**
Unit II	**Biodiversity and Environmental Laws** Biodiversity: Introduction, definition, Species diversity, threats to biodiversity. IUCN Red List category. Biogeography. Conservation of biodiversity: in-situ and ex-situ conservation, Bioreserves, Biospheres, Wildlife Sanctuaries, National parks, Marine parks, Global hotspots, RAMSAR sites. Wildlife Protection act 1972 and rules 2024. The Water (prevention and control of pollution) Act 1974. Forest Conservation Act 1980. The Air (prevention and control pollution) act 1981. Environment Protection Act 1986. Biodiversity Act 2002. National Green Tribunal Act 2010. Solid Waste Management Rules 2016.	**15 hrs.**
Unit III	**Planktons** Phytoplankton- Introduction to phytoplankton's, systematic classification of phytoplankton. Distribution -geographical, vertical, diurnal and seasonal migrations. Biology of Diatoms and Dinoflagellates. Factors affecting the distribution of phytoplankton. Primary productivity. Role of phytoplankton in global caron cycle,	**15 hrs.**

	impacts of climate change. Phytoplankton bloom – HABs and Red tide, causes and consequences. Bioluminescence. Zooplankton - Introduction, types, composition and diversity. Major zooplankton biology: Copepods, rotifers, crustaceans. Distribution – geographical, vertical, diurnal and seasonal migrations.	
Unit IV	**Applied Planktonology and Nekton, Benthos** Phyto-zooplankton interrelationship. Pollution indicator species. Plankton and Fisheries. Ecological significance. Production of biofuels. Phytoplankton toxins and pharmaceuticals, nutraceuticals and biotechnological industry. Nekton- taxonomic groups, horizontal and vertical distribution, factors affecting distribution. Benthos- Classification and categories of benthos. benthic structure and communities, the epifauna, infauna, general characteristics and adaptations. Collections and preservation of Benthos.	**15 hrs.**

Reference Book:

1. Abijit Mitra, Kakoli Banerjee, Bhattacharyya. D. P. (2006). Introduction to Marine Phytoplankton. Narendra Publication, New Delhi. ISBN 81-85375-13-5.
2. Dumont J. H., Green J and Masundire (2012). Studies on the ecology of tropical zooplankton. Springer Publication. 295 pages. ISBN 13978940 104 3823.
2. Gopal B. (2001). Marine Ecosystem. Kalpaz Publication. Delhi, ISBN 81-7835-059-9.
3. Kattel Giri (2012). Zooplankton and phytoplankton: types characteristics and Ecology. Marine Biology. UK edition. Nova Science publishers. Pp-240. ISBN 1397816 13245 088.
4. Kumar Pranav (2021). Fundamentals of Ecology and Environment. 3rd edition Pathfinder Publication. Pp-282. ISBN 13978 819 3465 509.
5. Nasar S. A. K and Datta Munshi J. (1975). Studies on Primary Production of Freshwater Pond. Japanese J. Ecol. 25 (1;21-23).
6. Perumal Santhanam, Agima Begum, Pachiappan P (2018). Basic and Applied Phytoplankton Biology. Springer.
7. Rana S. V. S. (2010). *Environment Studies*, Rastogi Publication, Meerut ISBN 81-7133-728-7.
8. Rana S. V. S. (2012). 1st edition (4th reprint) *Environment Studies,* Rastogi Publication, Meerut ISBN 81-7133-728-7.
9. Sharma P. D. (2013). *Environmental Biology and Toxicology*, 3rd revised edition, Rastogi Publication. Meerut. ISBN 13:978-81-7133-964-8.
10. Solanki D. & Naval R. (2023). Introduction to Environmental Science. AGPH Books, Bhopal, India.
11. Trivedi R. K. (1995). *Encyclopedia of Environmental Pollution and Control*. ISBN 81-86421-00-9.

Course Title: Environmental Science and Planktonology (Practical)

Course Code: A2MBK004P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire skills in in-situ collections of planktons, identification and enumeration. Analysis of primary productivity. Collection, and identification of benthos and seaweeds. Involve in Field visits.

Unit	Content	Hours
	1. Methods of collection of plankton, preservation techniques in plankton study and Analysis. Identification of phyto and zooplankton. 2. Evaluation of standing stock. Diel variation in plankton in estuary/bay. 3. Estimation of primary production by light and dark bottle method. 4. Chlorophyll estimation. 5. Permanent slide preparation of whole mounts of planktons. 6. Collection, segregation, identification and adaptations of benthos. 7. Collection and identification of economically important Seaweeds and their adaptation. 8. Visit to intertidal region - Rocky shores, Sandy shores, mud flats, mangrove forest and estuaries. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Aquaculture (Theory)

Course Code: A2MBK005T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn the principles and objectives of aquaculture and gain insight into the cultivable freshwater fishes.
CO 2	Learn the architect of fish pond construction, and maintenance and also learn different types of aquaculture systems.
CO 3	Learn pond management aspects, fish breeding technology and fish hatchery management aspects.
CO 4	Learn the important commercial and ornamental fish culture and their health management.

Unit	Content	Hours
Unit I	**Introduction to Aquaculture and Cultivable Freshwater Species** History of aquaculture. General principles underlying the practice of aquaculture. Scope and importance of aquaculture – Global and Indian scenario. Major cultivable species for aquaculture. Insight into inland water resources suitable for fish culture in India. Culture of Indian Major carps - Exotic carps. Food and feeding in culturable species. Nutritional requirements, principles of feed formulation, proximal composition of different feed. Feed conversion efficiencies of culturing organism	**15 hrs.**
Unit II	**Aquaculture Engineering** Aquaculture engineering- Construction of fish farm- criteria for fish farm site selection. Topography survey. Ecological survey, water quality, tidal range, layout design. Design of farm physical structures and construction. Equipment and facilities for fish farm operation and management. Culture in irrigation systems. Paddy fields, sewage disposals, raceways. Monoculture, polyculture. Integrated farming. Bottom and off-bottom culture. Rope culture, raft culture, pen culture. Sea ranching. Recirculating Aquaculture system. Culture systems: Recent advancement in indoor and outdoor aquaculture practices. Aquaponics.	**15 hrs.**
Unit III	**Pond Management** Farm management- Physical and chemical properties of soil and their impact on the construction and maintenance of ponds. Development	**15 hrs.**

	cost of fish farms. Water standards, quality and characteristics- salinity, pH, dissolved oxygen, temperature, alkalinity, hardness, ammonia, nitrate, nitrite, phosphate etc. Eradication of predators. Pond preparation. Transport of seeds. Pond management and feeding. Harvesting and marketing. Criteria for selection of species. Problems in rearing. Breeding technologies in fisheries. Seed production, Broodstock management. Fish hatchery management.	
Unit IV	**Commercial and Ornamental Fish Culture** Macrobrachium (scampi) culture. Salmon and catfish culture. Crop manipulation. Finfish diseases; Health, hygiene and quarantine measures in fishes. Introduction to ornamental fish culture. Freshwater species – live bearers and egg layers. Maturation, breeding habit, spawning, parental care and larval rearing of ornament fishes. Constructions of home/public aquarium. Aquarium fish- nutrition and disease management.	**15 hrs.**

Reference Book:

1. Ackefors H., Huner J., & Konikoff M. (2017). *Introduction to the general principles of aquaculture*. CRC Press.
2. Andrew P. (1999). *Economics of Brackish Water Shrimp Culture*. Daya Books.
3. Arumugam N, Murugan T, Johnson J. R and Ram R. P. (2010). Applied Zoology, Saras Publication, Kanyakumari.
4. Bardach J. E., Ryther J. H., & McLarney W. O. (1972). Aquaculture: the farming and husbandry of freshwater and marine organisms. Wiley Publications. ISBN: 978-0-471-04826-8.
5. Beavan R. (1877). *Handbook of the freshwater fishes of India*. digitallibraryindia; JaiGyan
6. Carvalho E., David G. S., & Silva R. J. (Eds.). (2012). *Health and environment in aquaculture*. BoD–Books on Demand.
7. Coche A. G, Muir. I F and Laughlin. T. (2000). Simple Methods of Aquaculture, Management of Freshwater Fish Csulture, Ponds and Water Practices, FAO, Bangkok.
8. Coche A. G., & FAO. (2006). *An indexed list of FAO publications related to aquaculture, 1964-2005*. FAO.
9. Chakrabarti N. M. (1998). *Biology, Culture and Production of Indian Major Carps-A Review*. Narendra Publishing House.
10. Eguia R. V. & Romana-Eguia M. R. R. (2004). *Tilapia farming in cages and ponds*. Aquaculture Department, Southeast Asian Fisheries Development Center.
11. Marx K. K., Sundaray J. K., Rathipriya A., & Abishag M. M. (2020). *Broodstock Management and Fish Seed Production*. CRC Press.
12. Pal R. N and Ghosh (1915). Aquaculture extension Manual, New series no.9, Central Inland Fisheries Research Institute. Barrackpora. West Bengal, India.
13. Srikrishnadhas B. & Sundararaj V. (2000). *Cultivable aquatic organisms*. Narendra Pub. House.
14. Upadhyay A. S. (1987). Few Improved designs of water inlet/ outlet structures of semi-intensive Aquaculture forums unpublishes paper presented in 1st Indian Fisheries forum Mangalore India pp17.
15. Venkataraman K. & Sivaperuman C. (2014). *Marine faunal diversity in India: taxonomy, ecology and conservation*. Academic Press.
16. Venkataraman K. & Raghunathan C. (2015). Coastal and marine biodiversity of India. In *Marine faunal diversity in India* (pp. 303-348). Academic Press.
17. Yadav B. N. (2006). Fish and Fisheries, Daya Publishing House, Delhi ISBN 81-705 17151
18. The ***FAO Fisheries*** and ***Aquaculture***.

Course Title: Aquaculture (Practical)

Course Code: A2MBK006P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire skills in cultivable fish identification, its biology, artificial feed preparation, and disease diagnostics. Visit fish farms and hatcheries to learn fish breeding techniques, fish ponds, and hatchery management.

Unit	Content	Hours
	1. Collection and identification of cultivable finfish. 2. Study the biology of Cultivable fishes. 3. Study of food and feeding in cultivable fishes. 4. Determination of maturity stages in fishes. 5. Fish seeds collection and analysis. 6. Identification of egg, larva, fry and fingerlings of fishes. 7. Induce Breeding experiments in fish. 8. Dissection and display of pituitary gland and preparation of extract. 9. Artificial fish feed preparation. 10. Common fish disease diagnostics and its management. 11. Study of Design, and layout of aquaculture pond and farm. 12. Culture pond preparation and its management. 13. Water and soil quality analysis of aquaculture pond. 14. Visit to freshwater fish hatchery to study hatchery management. (*New practical component may be added every year*)	**56 hrs.**

OEC: Open Elective Theory

Course Code: A2MBK027T

III – Semester

Course Title: Fishery Harvest and Post-Harvest Technology (Theory)

Course Code: A3MBK001T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	The topic will provide a comprehensive understanding of fishing gear and craft technology, encompassing historical and sustainable aspects, to empower students to contribute to the fishing industry.
CO 2	The content will delve into responsible and eco-friendly fishing methods and utilizing advanced technologies for long-term health sustainability of the fishing industry.
CO 3	The topic will provide knowledge of fish and shrimp handling. water quality management and various preservation methods contribute to the production of high-quality and safe seafood products.
CO 4	The unit will enlighten students with the knowledge and skills to ensure the safety, quality, and regulatory compliance of seafood products through chemical analysis, quality control programs, and proper fish handling practices.

Unit	Content	Hours
Unit I	**Fishing Gear and Craft Technology** Introduction, History & Evolution of fishing gears and crafts. Fishing methods- Surrounding nets, Seine nets, Trawls, Lift nets, Falling nets, Gill nets & Entangling nets, Traps, Hook & lines and Traditional Fishing gears of India. Fish finder- working principles, fishing without gear. Fishing gears and crafts of Uttara Kannada. Care and maintenance of gears- sterilization, tannin & coal tar and heat treatments. Maintenance of fishing vessels- docking the vessel in a dry dock. Hull preparation and painting. Life-saving appliances- lifeboat, life buoy, life jacket, life raft. Gear accessories: Floats- properties, low-density floats- wood, cork, thermocol, sponge plastic and rubber floats. High-density floats- glass, aluminum, steel, and fiberglass floats. Buoy- light buoy, radio buoy and dahn buoy. Sinkers and kites. Properties of natural and synthetic fibers. Types of craft building materials. International Standard Statistical Classification of Fishing Gears (ISSCG).	**15 hrs.**
Unit II	**Responsible and Ecofriendly Fishing Methods** Environmental Friendly Fishing. Energy Conservation in Fish Harvesting. Bycatch Reducing Devices (BRD). Turtle Excluder Devices (TED). Attachment of Square Mesh Window. Fish Eye. Electronics for Deep Sea Fishing- HF, VHF, SONAR, RADAR, ECHO Sounders, Net Sounder. Fuel Saving practices for Mechanized fishing vessels. Energy saving concepts in Trawling. Eco-Friendly Trawls for Semi-Pelagic Resources. Potential Fishing Zone (PFZ). Ocean State Forecast (OSF).	**15 hrs.**

Unit III	**Post-Harvest Technology** Handling of fish and shrimps onboard the fishing vessel- cleaning, sorting & evisceration, water supply, fish holds & containers and personal hygiene; Quality of water, ice and refrigerated seawater for seafood processing. Post-mortem changes in fish. Spoilage of fish- Bacterial, Enzymatic and Biochemical spoilage. Bacterial growth- requisite for bacterial growth. Bacteriology of fish and shellfish. Freezing of fish- Principles and mechanism of freezing and canning of fish; Principles and steps involved in canning; Curing- sun drying, salt curing, smoking of fish and radiation**.**	**15 hrs.**
Unit IV	**Quality Control of the Seafood Industry** Quality Control- Intrinsic and Extrinsic qualities. Quality Assessment of seafood by chemical methods. Quality control programs - Good Hygienic Practice (GHP), Good Manufacturing Practices (GMP), Sanitation Standard Operating Procedures (SSOP). HACCP Concept in Seafood Processing. Quality Assurance (QA), Quality Management (QM). National and International Quality standards for fish and fishery products – Bureau of Indian Standard (BIS), Food Safety and Standards Authority of India (FSSAI), Referral Food Laboratory. Packing and transportation of fresh and processed seafood. Minimum facilities required for approval of a seafood processing unit. Export inspection agency/Council.	**15 hrs.**

Reference Books:

1. Balachandran K. K. (2001). *Post Harvest Technology of fish and fish products.* ISBN 81-7035-237-1.
2. Bonnell A. D. (1994). *Quality Assurance in seafood processing*. Publishing in Great Britain ISBN 0-442-00879-1.
3. Hall G. M. (2009). *Fish Processing Technology.* B. A. P. Publication. New Delhi.
4. Jyoti M. K. and Sharma. A. (2006). *Fish aid in collection, preservation and Identification*. Daya Publishing House, Delhi.
5. Ninawe A. & Sand Rathnakumar K. (2008). *Fish Processing Technology and Product Development.* Narendra Publishing House, Delhi. ISBN 81-85-375-895.
6. Parthiban F. & Felixs F. (2022). Microbiology of fish and fishery products. Daya Publishing House, Astral Int. Pvt. Ltd. New Delhi.
7. Ronald A, & Corlett. Jr. (1998). *HACCP User's Manual*, Aspen Publishers, ISBN 0-8342-1200-5
8. Winton A. L and Winton K. B. (1997). *Fish and Fish Products.*
9. Winton A. L and Winton K. B. (2000). *Fish and Fish Products*, Jodhpur. India. ISBN 81-7754-029-7.

Course Title: Fishery Harvest and Post-Harvest Technology (Practical)

Course Code: A3MBK002P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	The content will provide knowledge on the fundamentals of fishing gear, vessel construction, fishing techniques, navigation, marine equipment, seafood processing, and microbiological techniques essential for the fisheries industry.

Unit	**Content**	**Hours**
	1. Identification of netting materials. Identification of gear accessories. 2. Construction of Cable netting yarn. Parts of fishing vessels. Preparation of knots, hitches and bends. Net making. 3. Study of hull shapes and positions. Study of operation of beach seine (Yendi). Study of typical backbone assembly. 4. Operation and demonstration of fishing methods - Trawling, Purse seining, Gill netting and other traditional fishing methods. Study of Navigational charts. 5. Study of signs of flags. Engine parts, GPS, Echo-Sounder, etc. 6. Study of Navigational equipment - Sextant, Azimuth mirror, Pyro techniques, Magnetic compass and Pelorus. 7. Sensory evaluation for assessing the quality of raw fish. 8. Enumeration of total bacterial load in ice, water and seafood. 9. Isolation of pathogens from seafood. 10. Visit to fishing plant processing and cold storage plant. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Animal Physiology, Endocrinology & Biochemistry (Theory)

Course Code: A3MBK003T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn a detailed account of the nutritive value of seafood, the digestive and circulatory systems of higher animals.
CO 2	Learn the comparative accounts of respiration, excretory, osmoregulatory and sense organs of the faunal community
CO 3	Learn a detailed account of animal endocrinology and immunology.
CO 4	Learn a detailed account of biomolecules, biochemistry and metabolism of macromolecules.

Unit	Content	Hours
Unit I	**Nutrition, Digestion, Circulation** Nutritional requirements, Food value, Diet formulation. Seafood nutrition- history and perspectives. Fish biochemical composition. Seafood nutritional supplements and health perspective. Digestive system, functions, organs and anatomy. Digestion and absorption in animals. A comparative account of the animal digestive system. Disorders of the digestive system. Blood. Composition and functions of blood. Fluid transport. The closed and open circulatory systems. Vertebrates' circulatory mechanism.	**15 hrs.**
Unit II	**Respiration, Excretion and Osmoregulation, Sense organs & thermoregulation** Integumentary, branchial, and pulmonary respiration. Respiratory pigments. Oxygen/ Carbon dioxide transport. Anaerobic respiration in animals**.** Basic aspects of the disposition of ammonia and nitrogen. Major nitrogenous end products. Interrelations between habitat and excretion. Ionic and osmotic regulation in animals. Chemoreception, Mechanoreceptions. Thermoreception and Photoreception. Propagation of nerve impulses. Cardiac, skeletal and smooth muscles. Mechanism of muscle contraction. Effect of temperature changes and acclimatization. Regulation of body temperature in birds and mammals. Aestivation and hibernation.	**15 hrs.**
Unit III	**Endocrinology & Immunology:** Comparative anatomy of endocrine glands. Structure, biosynthesis and biological actions of hormones. Structure and functions of hormone	**15 hrs.**

	systems of crustaceans and fishes. Overview of the immune system. Cells and organs of the immune system. Antigen & Antibody and its interactions. T-cell, B-cell and Cytokines. Vaccines.	
Unit IV	**Biochemistry** Principles of Biochemistry. Chemistry of Carbohydrates, Lipids, Protein, Nucleic acids and Vitamins. Classifications of Enzymes. Mechanism of action of enzymes. Kinetics of enzyme-catalyzed reaction activation, Enzyme inhibition, Co-enzymes, Metalloenzymes, Iso-enzymes. Metabolism of Protein and Lipids.	**15 hrs.**

Reference Books:

1. David M, Stokes P, Victoria M. (2020). Immunology. 9th Edition. Elsevier.
2. David Nelson & M. Cox (2004). Lehninger the Principles of Biochemistry. 4th Ed.
3. Goyal Sastry (2015-16). 6th Edition, *Animal Physiology*, Rastogi publication, Meerut. ISBN978-81- 7133-864-1.
4. Gupta S. N. (2015-16). *Concepts of Biochemistry*. Rastogi Publication, Meerut. ISBN 978-93-5078-092-3.
5. Sastry K. V. (2008). 1st edition, *Animal Physiology and Biochemistry*. Rastogi publication, Meerut.
6. Sastry K. V. (2016-17). 2nd Edition, *Animal Physiology and Biochemistry*. Rastogi publication, Meerut.

Course Title: Animal Physiology, Endocrinology & Biochemistry (Practical)

Course Code: A3MBK004P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire skills in hematological, biochemical quantitative and qualitative estimations.

Unit	Content	Hours
	1. Study of Blood groups. Hemoglobin content, hemolysis, blood coagulation, RBC, WBC and differential counts in any vertebrate representative. 2. Fish blood collection and analysis and enumeration. 3. Preparation of Biochemical Solutions: Percentage solutions, Molar solutions, Normal solutions, Dilution of Stock solutions. Buffer solution preparation and pH adjustments. 4. Quantitative Estimations of Carbohydrates, Protein, and Lipid from animal sources. 5. Qualitative Estimations of Carbohydrates, Protein, and Lipid from animal sources. 6. Immunological techniques 7. Constituents of normal and abnormal urine. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Mariculture (Theory)

Course Code: A3MBK005T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn brackish water mariculture systems and gain knowledge of cultivable species.
CO 2	Learn about hatchery management and live feed culture aspects.
CO 3	Learn the nutritional requirements, feed preparations and diagnostics of diseases and their control measures.
CO 4	Learn the broader aspects, and regulations involved in aquaculture management.

Unit	Content	Hours
Unit I	**Brackish Water Culture Systems and cultivable species** Brackish water aquaculture- Shrimp culture. Biology of cultivable Shrimps. Culture practices- Extensive, semi-intensive and intensive culture, super intensive culture systems. Recent developments in shrimp farming, Bio-floc culture practice. RAS culture practice. Paddy cum shrimp culture. Tidal range and pond construction. Recent advancement in Mariculture. Open Sea cage culture and estuarine cage culture practices. Culture of milkfish, mullets, GIFT tilapia, seabass, cobia, Seabreams, rabbit fish, groupers, Pompano. Recent advancement in marine mollusks and echinoderms farming – Mussel, oysters, clams and Sea-cucumber. Mud crab culture. Pearl culture technology. Seaweed culture.	**15 hrs.**
Unit II	**Hatchery Management** Hatchery management for shrimp and molluscan seed production. Specific Pathogenic Free Seed Production. Technique, collection, transportation and breeding of spawners. Induced maturation by eye stalk ablation. Larval rearing technique. Live feed culture: Algal culture and artemia culture, cladoceran and rotifer culture for hatchery production of seeds. Packing and marketing. Induced breeding in molluscs, spat settlement and collection.	**15 hrs.**
Unit III	**Nutrition and Pathology** Nutrition, food and feeding- Nutritional requirements of different shellfish and finfish species. Principle of feed formulation, proximate composition of different shrimp feeds. Pathology- Problems of diseases and parasites in brackish water culture. Common diseases of cultivable shellfish. Bacterial, fungal and viral diseases. Ecto and endoparasites of shellfish. Protozoan and helminthic diseases. Prophylaxis, diagnosis and therapeutic measures, Molecular disease diagnostics.	**15 hrs.**

Unit IV	**Aquaculture Management** Fish and Shrimp health management. Marine Integrated Multitrophic Aquaculture. Aquaculture Authority Act, Aquaculture Authority guidelines. Effluent treatment system in aquaculture, Marine Product Export Development Authority (MPEDA) in mariculture management. National Animal Care and Control Association. Guidelines for shrimp health management; Hazard Analysis Critical Control Point (HACCP) in aquaculture; Aqua club concept. Climate change impact on mariculture.	**15 hrs.**

Reference Books:

1. Ackefors H., Huner, J. & Konikoff M. (2017). *Introduction to the general principles of aquaculture*. CRC Press.
2. Agarwal S. C. (2007). *A handbook of fish farming*. Narendra Publishing House.
3. Aral F., & Dogu Z. (Eds.). (2011). Recent advances in fish farms.
4. Athithan S. (2020). *Coastal Aquaculture and Mariculture*. CRC Press.
5. Bardach J. E., Ryther J. H., & McLarney W. O. (1974). *Aquaculture: the farming and husbandry of freshwater and marine organisms*. John Wiley & Sons.
6. Barnabe G. (2018). *Aquaculture: biology and ecology of cultured species*. CRC Press.
7. Bensam P. (1999). *Development of marine fisheries science in India*. Daya Books.
8. Biswas K. P. (1992). Prevention and Control of Fish and Prawn Disease. Narendra Publishing House, Delhi
9. Carvalho E., David G. S., & Silva R. J. (Eds.). (2012). *Health and environment in aquaculture*. BoD–Books on Demand.
10. Gosling E. (2015). *Marine bivalve molluscs*. John Wiley & Sons.
11. Gosling E. (2021). *Marine mussels: ecology, physiology, genetics and culture*. John Wiley & Sons.
12. Mc.Vey J. P. (1993). *CRC Handbook of mariculture: crustacean aquaculture* (Vol. 1). CRC press.
13. Meade J. W. (2012). *Aquaculture management*. Springer Science & Business Media.
14. Pillai N. G. K. (2011). Marine fisheries and Mariculture in India. *Marine Fisheries and Mariculture in India*, 1-326.
15. Philipose K. K., Loka J., Sharma S. R. & Divu D. (2012). Handbook on Open Sea Cage Culture. CMFRI Publications.
16. Santhanam R. (2018). *Biology and ecology of edible marine bivalve molluscs*. Apple Academic Press.
17. Shelley C. & Lovatelli A. (2011). Mud crab aquaculture: a practical manual. *FAO Fisheries and aquaculture technical paper*.
18. Spencer B. (2008). *Molluscan shellfish farming*. John Wiley & Sons.
19. Srikrishnadhas B. & Sundararaj V. (2000). *Cultivable aquatic organisms*. Narendra Pub. House.
20. Suresh, V. V. R., Rajesh, N., Ignatius, B., & Gopalakrishnan, A. (2024). Mariculture in India: an overview.
21. Tucker Jr, J. W. (2012). *Marine fish culture*. Springer Science & Business Media.
22. Webste, C. D., & Jana, B. B. (2003). *Sustainable aquaculture: global perspectives*. CRC Press.

Course Title: Mariculture (Practical)

Course Code: A3MBK006P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire skills in cultivable finfish and shellfish identification, its biology, artificial feed preparation, and disease diagnostics. Visit to fish farm and hatchery to study finfish and shellfish breeding techniques, fish pond and hatchery management.

Unit	Content	Hours
	1. Study of brackish water pond design, layout and tidal range. 2. Equipment and facility used in mariculture. 3. Open sea cage culture tools. 4. Identification of marine culturable finfish and shellfish. 5. Study the biology of Shrimps and marine culturable fish 6. Food and feeding studies in finfish & shell fishes. 7. Induced breeding of molluscans. 8. Identification of larval stages of culturable species and rearing. 9. Spat collection technique. 10. Live feed culture. 11. Artificial shrimp feed preparation. 12. Disease diagnosis and therapy. Molecular disease diagnostics in aquaculture. 13. Visit to a shrimp hatchery. 14. Visit to an aquaculture farm. (*New practical component may be added every year*)	**56 hrs.**

Open Elective Theory
Course Code: A3MBK027T

IV Semester

Course Title: Fishery Resources and Management (Theory)

Course Code: A4MBK001T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	The unit will provide a comprehensive overview of the historical, current, and future aspects of global and Indian fisheries, including remote sensing applications, pelagic and demersal resources, and the significance of estuarine ecosystems.
CO 2	The unit will introduce students to a diverse array of marine organisms, including bony fishes, cartilaginous fishes, and various invertebrates, particularly focusing on India's rich shellfish resources.
CO 3	The unit will cover a wide range of value-added products derived from marine resources, including fish-based products, marine by-products, seaweed products, and chemicals extracted from seawater, highlighting their diverse applications in food, pharmaceuticals, and industry.
CO 4	Learn about the biotic and abiotic factors involved in fishery resource management.

Unit	**Content**	**Hours**
Unit I	**Fisheries Resources – I** History of fishery resources. Survey of fishery resources of the world. Present status and future prospectus of the fishing industry. Application of Remote sensing in fishery survey. Pelagic fishery resources of India. Oil sardine, lesser sardine and Indian mackerel. Estuarine fishery, milkfish, pearl spot, mullets. Chilka & Pulicate Lake Fisheries. Cochin backwaters. Aghanashini & Kali estuarine fisheries. Demersal Fishery resources of India- Bombay duck, tunas, billfish, swordfish and seer fish.	**15 hrs.**
Unit II	**Fisheries Resources II** Flying fish, ribbon fish, white baits, perch, elasmobranchs, catfish, Pomfret, and sciaenids. Silver bellies, threadfins, flatfishes, carangids, seaweeds, corals, sponges, echinoderms. Shell fishery of India: Shrimps, Molluscan-bivalves, gastropods and cephalopods - cuttlefish, squids & octopus.	**15 hrs.**
Unit III	**Fisheries Products and byproducts** Fish meal, fish body oil, Fish Protein Concentration (FPC), Pearl essence, fish glue, fish guano, and fish ensilage. Value-added fish products sausages, fish wafers, soup powder, fish pickles, clam pickles and squid rings. Ornamental and industrial fishes. Shark liver oil, shark fins, Fish maws and Isinglass, chitosan, ambergris, beche-de-mers. Seaweed products- agar, algin, iodine, edible seaweeds and seaweed products, and fertilizers. Chemical products from sea waters - Extraction and uses of salt, magnesium, magnesium sulfate, bromine, and heavy waters. Drugs from marine organisms.	**15 hrs.**

Unit IV	**Fisheries Resources Management** Fish reproduction systems. Mode of Reproduction: asexual, hermaphrodite, protandry, protogyny and sexual. Reproductive cycles – maturity stages, spawning periodicity and recruitment strength. Factors influencing reproduction – Biotic and abiotic. Food and feeding habits of commercially important finfish and shellfish. Energy flow and tropho dynamics in fisheries resources management. Applications of reproductive biology in fisheries resources management. Sea ranching. Impact of climate change, vulnerability, adaptations and mitigating strategies in resource management.	**15 hrs.**

Reference Books:

1. Bardach J. E., Ryther J. H. & McLarney W. O. (1974). *Aquaculture: the farming and husbandry of freshwater and marine organisms*. John Wiley & Sons.
2. Bensam P. (1999). *Development of marine fisheries science in India*. Daya Books.
3. Dholakia A. D. (2004). *Fisheries and aquatic resources of India*. Daya Books.
4. Kripa V., & Pravin P. (2017). CMFRI Marine Fisheries Policy Series No. 4; Indian Marine Fisheries Code: Guidance on a Marine Fisheries Management Model for India. *CMFRI Marine Fisheries Policy Series*, (4), 1-102.
5. Gopakumar G. (2010). Mariculture Technologies for Augmenting Marine Resources.
6. George P. C., Antony Raj B. T., & George K. C. (1977). Fishery resources of the Indian economic zone. *Souvenir issued on the occasion of the Silver Jubilee Celebrations of the Integrated Fisheries Project, Cochin.* 79-116.
7. Jhingran V. G., & Gopalakrishnan, V. (1973). Estuarine fisheries resources of India in relation to adjacent seas. *J Mar Biol Assoc India*, *15*, 323-334.
8. Jhingran V. G. (1982). Fish and fisheries of India.
9. Jhingran V. G. (1997). Fish and fisheries of India.
10. Joseph M. M., & Jayaprakash A. A. (2003). Status of exploited marine fishery resources of India. *Kochi: Central Marine Fisheries Research Institute*, *157*.
11. Lalitha H. M. (2021). *Fish Diversity of Karnataka–An Update*. Shineeks Publishers.
12. NAIR R. R. (2007). Aqua Sciences and Fisheries in India.
13. Rao G. S. (2012). Marine fisheries in India: The path ahead. Eprints@CMFRI.
14. Srikrishnadhas B., & Sundararaj V. (2000). *Cultivable aquatic organisms*. Narendra Pub. House.
15. Venkataraman K., Raghunathan C., Raghuraman R., & Sreeraj C. R. (2012). Marine biodiversity in India. *Published by Director, Zoological Survey of India, Kolkata*, 1-168.
16. Wafar M., Venkataraman K., Ingole B., Ajmal Khan S., & LokaBharathi P. (2011). State of knowledge of coastal and marine biodiversity of Indian Ocean countries. *PLoS one*, *6*(1), e14613.
17. **Online** book - Francis Day (1887). The Fishes of India. Vol. I & II.

- **Online websites:**
- http:/fishbase.se
- www.Sealifebase.se

Course Title: Fishery Resources and Management (Practical)

Course Code: A4MBK002P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	The students will acquire knowledge of the taxonomy, morphology, and length-weight relationships of commercially important finfish and shellfish. Fish market surveys, fishing areas, shipyards, marine research institutes, fish landing centres, ice plants, fish meal plants, and processing plants will enhance practical knowledge.

Unit	Content	Hours
	1. Introduction to fish taxonomy and its components. 2. Identification and classification of commercially important fin fishes of Karwar. 3. Morphometric and meristic studies. 4. Length-weight relationship of fin fish. 5. Study of fish reproductive biology – Maturity stages and Gonadosomatic indices. 6. Fish market survey and report. 7. Visit fishing places and fish landing centers. 8. Visit Marine Research Institutes. 9. Visit ice plants and fish meal plants. 10. Visit to fish processing plants. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Marine Biotechnology (Theory)

Course Code: A4MBK003T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn the importance of biotechnology in marine science and cell culture techniques.
CO 2	Learn the environmental management through biotechnological remediation.
CO 3	Learn the advanced biotechniques in aquaculture and molecular disease diagnostics.
CO 4	Learn the scope, isolation, and commercial production of marine natural bioactive compounds.

Unit	Content	Hours
Unit I	**General Biotechnology** Origin. History of Biotechnology. Definition. Biotechnology as an interdisciplinary activity. Scope and importance of Biotechnology. Biotechnology in India. Requirement for animal cell and tissue culture. Substrates for cell growth. Culture media. Sources of cell. Techniques of obtaining cells by disaggregation of tissue. Culture procedures - storage, preservation and retrieval of culture. Large-scale culture of cell lines. Applications of cell culture products.	**15 hrs.**
Unit II	**Environmental Biotechnology** Introduction of Biotechnology for pollution abatement. Use of Genetically Engineered organisms for removal of specific pollutants. GEM for oil spills, GEM for degrading pesticides and GEM for sequestering heavy metals. Biotechnological bioremediation. In situ bioremediation. Ex situ bioremediation. Bioremediation of specific pollutants. Phytoremediation's. Methods of Phytoremediation. Biosorption and Bioleaching.	**15 hrs.**
Unit III	**Aquaculture Biotechnology** Introduction. Transgenic fish, Production of transgenic fish. The technique of transfer of transgene. Microinjection, electroporation, sperm-mediated transfer, Retroviral vectors, biolistics and lipofection. Cryopreservation in Marine organisms. Prospects of aquaculture biotechnology in India. Diagnostics in aquaculture. Enzyme-Linked Immunoassay, Dot Immunobinding Assay, Western blotting, Gene cloning, DNA-based Diagnostics, Polymerase Chain Reaction, Nucleic acid probes. Recombinant DNA technology. Disease management technologies.	**15 hrs.**
Unit IV	**Marine Natural Products** Marine natural products. Bioactive marine natural products - anti-tumor compounds, anti-inflammatory/analgesic compounds, anti-viral agents, Isolation of bioactive compounds - liquid extraction, membrane separation, chromatography. Identification of marine bioactive compounds - IR, UV, NMR and mass spectroscopy. Commercial development of marine natural products- Agar, chitin.	**15 hrs**

Reference Books:

1. Gupta P. K. (2015-2016). Molecular Biology and Genetic Engineering, Rastogi Publication, Meerut. ISBN 81-7133-719-8.
2. James G. A., Warwood K., Hiebert R., Cunningham A. B. (2000) Bioremediation. Springer, Netherlands. ISBN: 978-90-481-5519-4.
3. Kwom Kim (2020). Encyclopedia of Marine Biotechnology. Wiley Publication.
4. Milton Fingerman, R. Nagabhusanam. (2005). Bioremediation of Aquatic and Terrestrial Ecosystems. Science Publishers.
5. Milton Fingerman. (2003). Recent Advances in Marine Biotechnology, Vol. 8: Bioremediation. CRC Press.
6. Pandian T. J. (2005). Fish Genetics and Aquaculture Biotechnology. CRC Press.
7. Rajan. S and Selvi R (2010). *Experimental procedures in Life Sciences*, Anjanaa Book Hous. Chennai. ISBN-978-81-910165-05.
8. Ramdas. P (2008). *Animal Biotechnology*-MJP, Chennai.
9. Se-Kwon Kim. (2015). Handbook of Marine Biotechnology. Springer-Verlag Berlin Heidelber. ISBN: 9783642539701,9783642539718.
10. Shubha Agarwal Govil. (2015). Marine Biotechnology. Himalaya Publishing House. ISBN: 978-93-5433-201-2.

Course Title: Marine Biotechnology (Practical)

Course Code: A4MBK004P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire hands-on skills with microbiological/biotechnological techniques, bacterial culture, microalgae culture and isolation of DNA.

Unit	Content	Hours
	1. Laboratory rules and basic requirements in the microbiology/Biotechnology laboratory. 2. Sterilization techniques -Physical and chemical methods. 3. Preparation of culture media - Preparation of saline, borth (liquid media) and solid media. 4. Pure culture technique – pour plate, spread plate, streak plate, serial dilution. Colony morphology of bacteria. Staining methods. Preparation of smears. 5. Bacterial motility study-hanging drop method. 6. Determination of bacterial growth. 7. Effect of pH, and salt concentration on bacterial growth 8. Antimicrobial sensitivity test and demonstration of drug resistance 9. Extraction of DNA from bacteria. 10. Estimation of DNA by Diphenylamine method 11. Agarose Gel electrophoresis, SDS-PAGE Electrophoresis (demo) 12. Study of tissue culture technique and equipment. Preparation of Cell culture medium. 13. Collection, isolation, and culture of Microalgae 14. Enzyme-linked immunosorbent Assay (demonstration) 15. PCR technique (demo) 16. Cryopreservation of Gametes. 17. Visit to Biofuel production center. (*New practical component may be added every year*)	**56 hrs.**

Course Title: Fishery Economics and Management (Theory)

Course Code: A4MBK005T

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn the concepts and theories of fishery economics.
CO 2	Learn about the growth in the fishery sector and the present scenario of fisheries.
CO 3	Insight into the global and Indian fishery export scenario.
CO 4	Understand the holistic fisheries management strategies.

Unit	Content	Hours
Unit I	**Fisheries Economics:** Introduction of fishery economics, basic concepts of economics – micro/macroeconomics. Theory of demand. Consumer behavior. Consumer surplus. Market demand. Houthakker's and Tailor's dynamic demand models. Structure of fishing industry & manpower requirements. Financial requirements in the fishing industry. Fish marketing – concept and scope, market structure, marketing strategies, problems in marketing fish and fishery products, and recent developments in fish marketing.	**15 hrs.**
Unit II	**Blue Revolution** Growth of fisheries – Indian and international perspective. Concept of Blue revolution and its objective. Pradhan Mantri Matsya Sampada Yojana – aims and objectives. The role of the National Fishery Development Board in fishery development. Trends and lands of potential yield from Indian exclusive economic zone. Joint ventures. Fisheries extension. Role of banking institutions in the fishing industry, principles of fisheries financial management, innovations in fisheries financing – microfinance, Kisan credit cards, private sector banks, Fishermen co-operatives in Karnataka State & Uttara Kannada District, Self-Help Group.	**15 hrs.**
Unit III	**Fisheries Export** Global fishery production - Capture fisheries and Culture Fisheries. Indian fisheries production. Global fisheries export scenario. Indian fisheries export scenario. Export growth and trends of marine products in India. Ornamental Fisheries. The role of marine product export development authority in fisheries product export. Export certifications. HACCP implementations. Quality standards. Export-import producers. Timescale performance and patterns of Indian seafood export. Socio-economic aspects of fishing industries.	**15 hrs.**
Unit IV	**Fisheries Management** Fisheries management theories and objectives – Catch per unit effort, Maximum sustainable yield. Economics of different fishing units. Biological and ecosystem theory of fisheries management. Stock enhancement. Issues in fisheries- Overexploitation, pollution, habitat degradation/ biodiversity loss, Environmental flows; Exotics; transboundary issues and Climate	**15 hrs.**

	change. Modern and holistic theory of fisheries management. Global theory of fisheries management. Sustainable fisheries management. National Fisheries Policy 2020. Time series of Indian Fisheries Act. Maritime States Fisheries Act. Marine fisheries policies in India. Fisheries Education, Training & National and international organizations. International Law of Marine Fisheries.	

Reference Books:

1. Anderson G. L., Seijo J. C. (2011). Bio-economics of Fisheries Management. Wiley's Publishing House.
2. John C. Sainsbury (1989). Commercial fishing methods: Introduction to vessel and gear. Wiley Blackwell. ISBN-10: 0852381425.
3. Datta Munshi and Srivastava (2006). Reprint, *Natural history of Fishes and Systematic of freshwater fishes of India*, Narendra Publishing House, Delhi ISBN 81-85375-12-7.
4. Balber Stephen J. M. (2013). Fish and fisheries in tropical estuaries: the last 10 years. https://doi.org/10.1016/j.ecss.2012.11.002.
5. Rekha R. Gaonkar (2011). Fishery management. APH Publishing Corporation. ISBN-10 : 8131303209
6. Fishing Chymes – Quarterly Journal. India.
7. Nandi D. (2020). Fundamentals of Remote Sensing and GIS. Kunal Books Publisher, New Delhi.
8. Ninawe A. S and Rathnakumar. K. (2008). *Fish processing Technology and Product development*, Narendra Publishing House, Delhi. ISBN 81-85-375-89-5.
9. Shukla J. P. (2016-17). *Fish and Fisheries*, Rastogi publications, Meerut. ISBN978-81-7133-967-9.
10. Simon. J. Michel J. K and John D. R. (2001). *Marine Fisheries Ecology. ISBN: 978-0-632-05098-7. Wiley-Blackwell. 432 pages.*

Online reference:

- www.nfdb.gov.in
- www.mpeda.gov.in
- www.fsi.nic.in
- www.cmfri.org.in

Course Title: Fishery Economics and Management (Practical)

Course Code: A4MBK006P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs.**	**4 hrs.**	**10**	**40**	**50**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO	Acquire skills in shellfish taxonomy and modern techniques in fisheries management. Learn research methodologies.

Unit	Content	Hours
	1. Identification and classification of commercially important shrimps and carbs. 2. Identification and classification of edible Clams and oysters. 3. Study of catch composition and economics of different fishing gears and crafts (Trawl and Purseine). 4. Shore seine catch composition and economics (Yendi catch composition). 5. Global Information System (GIS) techniques – fundamental concept of GIS, components of GIS. GIS data models, Data sources. 6. Remote Sensing techniques- Introduction to remote sensing, Satellites and their characteristics, Satellite remote sensing & sensors. 7. Applications of remote sensing and GIS in fisheries and Aquaculture. 8. Research methodology and Descriptive statistics. (*New practical component may be added every year*)	**56 hrs.**

Course Title: PROJECT

Course Code: A4MBK007P

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Project**	**06**	**-**	**-**	**-**	**30**	**120**	**150**

P.G. Program Marine Biology: 2024-2025

The General Pattern of Theory Question Course for DCS

80 marks for the semester-end Examination with a 3-hour duration

Part A

1. Question numbers 1- 4 carry 15 marks each. Answer and **Two** questions**.** **30 marks**

Part B

2. Question numbers 5 – 10 carry 10 marks each. Answer any **Three** questions. **30 marks**

Part C

3. Question numbers 11 – 20 carry 2 marks each. Answer all Ten questions**.** **20 marks**.

Total– 80 Marks.

Note: Proportionate weightage shall be given to each unit based on the number of hours, prescribed.

KARNATAK UNIVERSITY DHARWAD

DEPARTMENT OF STUDIES IN MARINE BIOLOGY
Post Graduate Centre, Karwar.

Syllabus

For

OPEN ELECTIVE COURSE (OEC)

Offered by

Marine Biology

(II & III Semesters)

As per NEP 2020

From
2024-25 onwards

Course Title: Marine Ecology (Theory)

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/ hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn the basic concept and significance if ecology.
CO 2	Understand ecosystem structure, productivity and biogeochemical cycles.
CO 3	Learn the concept of marine ecology, oceanic divisions and community structure.
CO 4	Learn the physico-chemical and biological properties of various marine ecosystems.

Unit	Content	Hours
Unit I	**Introduction to Ecology** Definition of Ecology. Historical background of ecology. Basic concept of ecology. Major divisions of ecology. Abiotic factors – types, essential elements and limiting factors. Biotic factors and communities. Ecological succession. Ecological tools and techniques. Significance of ecology for mankind. Ecology in India.	**15 hrs.**
Unit II	**Ecosystem structure and function:** Kinds of ecosystem. Functions of ecosystem. Productivity of ecosystem. Food chain and ecological pyramids. Energy flow. Biogeochemical cycles. Atmospheric Cycles - Water cycle, oxygen and carbon. Edaphic nutrient cycles – Nitrogen, Phosphorus and Sulphur.	**15 hrs.**
Unit III	**Marine Ecology:** Introduction to the marine realm. Oceanic province, divisions and zonation. Characteristics Continental shelf, slope, abyssal and hadal zone. Characteristics and classifications of Pelagic and benthic zone. Community structure in Oceanic division. Between the tide – characteristics and community structure of Intertidal zone, rocky, sandy muddy shore.	**15 hrs.**
Unit IV	**Marine Ecosystems:** Estuarine ecology. Types of estuaries. Physico-chemical aspects of estuaries. Biotic communities of estuaries. Mangrove diversity, distributions and ecological adaptations. Mudflats ecosystem. Wetland ecosystem. Important Estuaries of India. Tropical estuaries of Karnataka: Kali, Gangavali, Aghnashini, Sharavati, Panch Gangolli and Netravati estuaries. Coral reefs – kinds of reef and ecological significance of coral reefs	**15 hrs.**

Reference Book:

1. Agarwal V. K and Verma P. S. (1997). *Concept of Ecology, Environment Biology*, 03 257 1/e, pp272
2. Datta Munshi. J and Datta Munshi. J. S. (1995). *Fundamentals of Freshwater Biology*, Narendra Publication, Delhi.
3. G. Karleskint & R Turner (2012). Introduction to Marine Biology. Unleash –Inc. ISBN: 978-1133364467.
4. Michael H & Peter C. (2009). Marine Biology. Apex media. ISBN – 978-0073524160.

Course Title: Environmental Biology and Pollution (Theory)

Type of course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/ hours/ semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OEC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course Outcomes (Cos): At the end of the course, students will be able to:	
CO 1	Learn different spheres of the environment and environmental conservation, and education management.
CO 2	Learn concepts of biodiversity, biogeography, conservation of biodiversity and environmental laws.
CO 3	Learn the concepts, regulations and techniques involved in environmental impact assessment.
CO 4	Understand the various types and sources of pollution and will learn pollution control, prevention and mitigation measures.

Unit	Content	Hours
Unit I	**Environment and its Components** Structure and component of the environment – Atmosphere, Hydrosphere and Lithosphere. Biosphere – Organizational levels of biosphere. Population and community ecology. Food pyramids. Energy flow. Types of natural resources – Forest, Water, Mineral, Marine. Renewable and non-renewable resources. Growing energy needs. Use of alternate energy source. Conservation and management. Environmental education and awareness. Environmental institutes and governing bodies.	**15 hrs.**
Unit II	**Biodiversity and Environmental Laws** Biodiversity: Introduction, definition, Species diversity, threats to Biodiversity. IUCN Red List category. Biogeography. Conservation of biodiversity: in-situ and ex-situ conservation. Bioreserves, Biospheres, wildlife sanctuaries, National parks, Marine parks, Global hotspots, RAMSAR sites. Wildlife Protection act 1972 and rules 2024. The Water (prevention and control of pollution) Act 1974. Forest Conservation Act 1980. The Air (prevention and control pollution) act 1981. Environment Protection Act 1986. Biodiversity Act 2002. National Green Tribunal Act 2010. Solid Waste Management Rules 2016.	**15 hrs.**
Unit III	**Environmental Impact Assessment** Marine and coastal impact assessment. Coastal Regulatory Zone notification. Shoreline changes due to development. Coastal management issues - comparison between temperate and tropical countries - Integrated coastal zone management. Introduction to Environmental Impact Assessment (EIA). EIA notifications of the Government of India from time to time. Categorization of projects. EIA processes, Scoping and EIA methodologies, Procedure for reviewing Environmental impact analysis and statement. Remote sensing and GIS techniques.	**15 hrs.**
Unit IV	**Pollution** Types of pollution. Source of pollution. Marine pollution – Source of	**15 hrs.**

	pollution. Oil pollution, Solid waste and plastic pollution, thermal pollution, nuclear hazard, anthropogenic and industrial pollution. Impact of mining and dredging. Pollution control, prevention and mitigating measures. Role of Central and State Pollution Control Board. Bioaccumulation, biotransformation and biomagnification. Bioindicator organisms. Global warming and climate change. Ozone depletion. Acid rain and its impact.	

1. Ananda Rao T and Suresh P. V. (2009). Coastal Ecosystem of Karnataka State, India, Mangroves, Karnataka Association for Advancement of Sciences Bangalore
2. Sharma P. D. (2013). *Environmental Biology and Toxicology*, 3rd revised edition, Rastogi Publication, Meerut. ISBN 13:978-81-7133-964-8
3. Sharma P. D. (2015-16). *Ecology and Environment*, A textbook for University Students 12th edition, Rastogi Publication. Meerut. ISBN 978-91-5078-068-8
4. Venkataraman. K, Rajkumar. R, Satyanarayana C. H, Raghunathan C and Venkatraman C. (2012). Marine Ecosystem and Marine Protected areas of India, Zoological Survey of India, Chennai, Kolkata ISBN 978-81-8171-312-4