Faculty of Science, M.Sc. (Marine Biology)

Semester Scheme (2019)

Regulations: Effective from July 2019

R.M.Sc. 1 (A) Admission

For the Admission to first semester of M.Sc. degree in Marine Biology, A candidate who has passed a graduation degree of three years duration from a recognized university or equivalent in subjects marine science/ zoology/ botany/ microbiology/ biotechnology/ bioinformatics/ fisheries/ forestry/environmental science/agriculture/veterinary science or the candidate have passed second year B.Sc with any of the subjects mentioned above as subsidiary subjects may become eligible to apply for admission with minimum qualifications (48%) as prescribed from time to time.

(B) For admission to second semester: a candidate will be admitted to second semester irrespective of result of examination of first semester.

(C) For admission to third semester: a candidate who has passed all the examinations of first semester will be admitted to third semester irrespective of result of exam of second semester.

(D) For admission to fourth semester: a candidate who has passed first and second semester exam will be admitted to fourth semester irrespective of result of examination of third semester.

R.M.Sc. 2 Choice of Courses

In addition to the core or compulsory courses offered, Some of the non compulsory courses may be available in other subjects of the Faculty of Sciences or any other faculty under the conditions laid down from time to time.

R.M.Sc. 3 Credits

A candidate will be conferred the Master degree in Marine Biology only if he/she accrues minimum of 112 credit points in the four semesters. One credit point in theory will be one hour per week running for 15 weeks and one credit for practical course would be equivalent to 18 hours of laboratory exercises during first to fourth semester for the practical as well as dissertation in fourth semester.

R.M.Sc. 4 Duration of Degree

The degree of M.Sc. Marine Biology is spread over four semesters. To pass the whole M.Sc. Examination, student should clear all the four semester examinations within a period of ten semesters from the date of first admission to M.Sc. After this period he/she shall be required to register himself/herself as a fresh candidate, and keep the attendance and appear and pass the four semester examinations afresh from first semester onwards in order to obtain the Degree of Master of Science.

R.M.Sc. 5 Term keeping

A candidate who fulfills the requirements of minimum attendance and any other rules needed by the department, would be said to have kept terms for that semester.

Requirement of Attendance: No candidate shall be considered to have pursued a regular paper of study unless he/she has attended 75% of the total number of

sessions conducted in each semester.

Any student not complying with this requirement will not be allowed to appear in the semester end examination. However, the Head of the Department in consultation with departmental committee may condone the required percentage of attendance by not more than 10 % during a semester.

All other cases below 65% of attendance will be referred to vice Chancellor for his discretion to allow the student to appear in Examination.

If a student is going out of class to officially represent the university / department with permission of the Head of the Department in local / state / national/ international activities his / her attendance would be compensated. Such exemption should normally not exceed 20 days in a semester for academic programs and 10 days for cultural and sports activities.

R.M.Sc. 6 Examinations

(A) There shall be an examination at the end of each of four semesters to be known as First Semester Examination, Second Semester Examination, Third Semester Examination and Fourth Semester Examination respectively at which a student shall appear in that portion of papers, practical and *viva-voce* if any, for which he/she has kept the terms in accordance with the regulations R.M.Sc. 5.

(B) In order to help the students to evaluate and improve themselves continuously, the internal examinations would be planned and conducted throughout the semester by the department. The Continuous Internal Assessment (internal examination) may have components like written tests, oral tests, assignments, seminars, presentations, practicals, dissertation/ projects, industrial / institutional/field visits and other innovative methods of examination, and any combinations of these. Regularity and attendance may also be assessed for marking.

(C) To pass the M.Sc. degree examinations a candidate shall be required to obtain at least 40% marks, (the minimum marks necessary to pass), in each paper (separately in both the internal and the semester end examinations). The ratio of marks between external and internal examination would be 70:30.

(D) If a candidate is not able to obtain minimum marks in any paper (either in Internal or External evaluation) he/she would be required to pass the same within the time limit as prescribed above with the conditions mentioned in R.M.Sc. 1.

(E) Dissertation/Project commences in Third semester but evaluated and grade point are to be added in 4th semester. Educational Tours/ Field works may be carried out in any semester or all semesters, but evaluated / Grade points are to be added in 4th Semester only.

R.M.Sc. 4 Grades / Passing

For each course the Grades shall be awarded at the M.Sc. degree in the manner specified herein below, namely the UGC 7 point scheme

Percentage of Marks Obtained	Grade	Grade Points
100 – 75	O – Outstanding	6
< 75 – 65	A – Very Good	5
< 65 - 55	B – Good	4
< 55 – 50	C – Average	3
< 50 – 45	D – Satisfactory	2
< 45– 40	E – Pass	1
Less than 40	F – Fail	0

Results at the end of semester will be declared using grade point system. The final Grade Point Average is weighted average and would only be calculated after a student has passed courses and accumulated required number of credits as in R.M.Sc. 3.

The GPA will be printed on the final mark-sheet only.
The Grade Point Average (GPA) would be calculated by the following formula:

GPA = (Sum of (Grade Points Earned X Credit for each Course)) / (Total Credits for the degree)

The final grades would be awarded as shown below:

Grade Point Average	Grade
05.00 - 06.00	O
04.55 – 04.99	A
03.50 – 04.49	B
02.50 – 03.49	C
01.50 – 02.49	D
00.50 – 1.49	E
00.00 – 00.49	F

If the GPA is higher than the indicated upper limit in the third decimal point then the next higher grade would be awarded (e.g. GPA of 4.492 would be equivalent to 'A' grade)

M.Sc. MARINE BIOLOGY

SYLLABUS

Semester-1

Paper No.	Title of the Paper	Maximum Marks		Minimum Marks required to Pass		Teaching hrs per week	Exam hrs	Credits	Interdisciplinary
		Internal	External	Internal	External				
Paper-1	Ecology	30	70	12	28	15 week x 4 hrs. = 60	2.30	4	Y
Paper-2	Oceanography	30	70	12	28	15 week x 4 hrs. = 60	2.30	4	Y
Paper-3	Marine Biodiversity	30	70	12	28	15 week x 4 hrs. = 60	2.30	4	N
Paper-4	Practical	100		40		15 week x 18 hrs. = 270	24	18	N
						Total credit of Semester - I		**30**	

Semester-2

Paper No.	Title of the Paper	Maximum Marks		Minimum Marks required to Pass		Period of one hr per week	Exam hrs	Credits	Interdisciplinary
		Internal	External	Internal	External				
Paper-5	Biochemistry, Genetics, and Molecular biology	30	70	12	28	15 week x 4 hrs. = 60	2.30	4	Y
Paper-6	Instrumentation, Biostatistics and Research Methodology	30	70	12	28	15 week x 4 hrs. = 60	2.30	4	Y
Paper-7	Conservation & Management of Marine Biota and Eco-tourism.	30	70	12	28	15 week x 4 hrs. = 60	2.30	4	N
Paper-8	Practical	100		40		15 week x 18 hrs. = 270	24	18	N
						Total credit of Semester – II		**30**	

Semester-3

Paper No.	Title of the Paper	Maxi Ma
		Inte rnal
Paper-9	Aquaculture	30
Paper-10	Fishery Science	30
Paper-11	Processing & preservation technology of fish and its products	30
Paper-12	Practical	10

Paper No.	Title of the Paper	Maxi Ma
		Inte rnal
Paper-13	Marine pollution, ocean management and effect of climate change	30
Paper-14	Costal Regulation Zone, various Costal resources and Remote Sensing	30
Paper-15	Environment monitoring and Marine Biotechnology	30
Paper-16	Practical 50 Marks Dissertation 50	10

Detailed Syllabus
M.Sc. Marine Biology
Semester: I
Paper No: 1

Title of the Paper: Ecology

Credits: 4 Marks: 100 Marks

Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Marine ecosystems: Sea as a biological environment, Oceans of the world, Division of marine environment, Distribution of marine life, Ecology of Coral reef	16	18
Unit 2	Animal, microbial and plant communities; their relationships. The concept of food web, food chain, trophic structure, Ecological pyramids, energy flow. Ecology of Coral	16	18
Unit 3	Concept of ecology: Community ecology, population ecology and community dynamics.	14	17
Unit 4	A Detailed study of Marine Habitat with special emphasis to Coastal Wetlands and Inland Wetlands.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Odum, EP, *Fundamentals of Ecology* (3rd ed.) Saunders, (1968).
2. Sheppard, C., Price, A. and Roberts, C. Marine Ecology of the Arabian Region. Academic Press Limited, London. 1992.
3. Dey, S. and Nasrin, B. Ecology of Aquatic System. Scientific International Pvt. Ltd. 2016.
4. Kormondy, EJ, *Concepts of Ecology* (4th ed.) Prentice Hall, (1986)
5. Kumar, HD, *Modern Concepts of Ecology*, Vikas Publ. House, New Delhi(1986)
6. Bames, RSK & Hughes, RN, *An Introduction to marine Ecology,* Blackwel(1982)
7. Levingston, JS, *Marine Ecology,* Prentice Hall, (1982)
8. Longhurst, AR & Pauly, D, *Ecology of Tropical Ocean,* Academic Press,(1987).
9. Walker P. and Wood, E. The Coral Reef. An imprint of Infobase Publishing. New York. 2005.
10. Sorokin, Y. I. Coral Reef Ecology. Springer-Verlag Berlin Heidelberg . 1995

M.Sc. Marine Biology
Semester: I
Paper No: 2

Title of the Paper: Oceanography

Credits: 4 Marks: 100 Marks

Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Geology of Ocean: Origin of the ocean & continents, Plate Tectonics. The elements and geochemical cycles of oceans. Sulphur, Phosphorous, Nitrogen and Carbon cycles. Major and Minor elements. Dissolved and particulate organic matters. Marine archeology of India.	16	18
Unit 2	Physical properties of sea water: Temperature, pressure, density, color, light and sound transmission in sea water, heat budget and water masses. Ice formation. Chemistry of sea water: Chemical composition of sea water Salinity and Dissolved gases of sea water.	16	18
Unit 3	Introduction and history of Oceanography. Important oceanographic research institutes in the world. Oceanography and its opportunity. History of important ocean expeditions.	14	17
Unit 4	Ocean circulation: Factors affecting ocean circulation, Vertical and horizontal circulation, Langmuir circulation, El Nino and La Nino. World ocean currents. Waves, tides, tsunami, storm, surges.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Dietrich, G, *General Oceanography, an Introduction*, (1963)
2. Hill, MN, (ed.) *The Sea Vol.II*, Interscience publishers, (1963)
3. Weyl, RR, *Oceanography, an Introduction to Marine Environment* John Wiley,(1974)
4. Vetter, RC, *Oceanography, the Last Frontier, Voice of America*
5. Forum Press, (1974)
6. Weisberg, J, & Parish, P, *Introductory Oceanography*, Mc Graw Hill, (1974)
7. Ferguson wood, EJ, *The Living Ocean,* St. Martin's Press, N.Y. (1975)
8. Gordon Pierie, R, *Oceanography,* Oxford Univ. Press, (1977)
9. Ross, DA, *Introduction to Oceanography* (4th ed.) Prentice Hall, (1977)
10. Roos, DA, Introduction to Oceanography, Prentice Hall, (1982)
11. Thurman, HV, *Introduction to physical Oceanography*, Merril Publ. Co. (1988)
12. Von arx, WS, *An Introduction to Physical Oceanography*, Addison – Wesley, (1964)
13. Newman, GS, & Pierson, WJ, *Principles of Physical Oceanography,* Prentice Hall, (1965).
14. Riley, JP, & Shirrow, G, (eds.) *Chemical Oceanography*, (Vol 1-8, Academic Press.
15. Riley, JP & Chester, R, *Introduction to Marine Chemistry,* Academic Press, (1981).
16. Millero, FJ, & Sohn, ML, *Chemical Oceanography*, CRC Press, (1992).
17. Angel, MV, *Biological Oceanography*, Methuen, (1975).

M.Sc. Marine Biology
Semester: I
Paper No: 3

Title of the Paper: Marine Biodiversity

Credits: 4 Marks: 100 Marks

Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Biodiversity of the marine habitat. Definition and concepts of species diversity, ecosystem diversity, genetic diversity, Importance and conservation of biodiversity. Marine larvae methods of collection and preservation of plankton.	16	18
Unit 2	Marine Microbes: Diversity of microorganism Archaea, Bacteria, Cyanobacteria, microalgae, fungi, viruses and actinomycetes in marine environment, Red water phenomenon and bioluminescence.	16	18
Unit 3	Marine fauna: classification, distribution, importance and utilization. Intertidal habitat of flora and fauna and their diversity. Marine planktons: Definition and classification, Migration of plankton	14	17
Unit 4	Marine algae and angiosperms: Classification, morphology and biology of marine algae with special emphasis on their utilization, sea grasses. Mangroves and other halophytes (distribution, classification, morphology and biology).	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Austin, B, *Marine Microbiology,* Cambridge Univ. Press, (1988).
2. Fredrich, H, *Marine Biology* of Sidgwick & Jackson, (1969).
3. Lobban, CS, & Wynne, MJ, *The Biological of Seaweeds*, Blackwell, (1981)
4. Nair, MB, & Thamphy, DM, *A Text Book of Marine Biology*, Mac millan, (1980).
5. Nicol, JAC, *The Biology of Marine Animals*, Pitman, (1960).
6. Parsons, TR, Takhasi, M, & Hargrave, B, *Biological Oceanographic Processes,* Perqmon (1977).
7. Sieburth, J. MC N., *Sea Microbas*, Oxford Univ. Press, (1979).
8. Southward, AJ, *Life on the Seashore*, Heinemann, (1965).
9. R. Santhanam, N. Ramanathan, K. Venkataramanujum. *Phytoplankton of the Indian seas*. (2005)
10. Mitra, A. *Introduction to Marine Phytoplankton.* Narendra Publishing House, Delhi (1999).
11. Kumar Arvind. ed Ecology of Plankton Daya Publication, New Delhi (2002).

M.Sc. Marine Biology
Semester: I
Paper No: 4

Title of the Paper: **Practical**
Credits: 18 Marks: 100 Marks

Sr. No	Practical	No. of Practical	Hrs. required
1.	Ecological estimation: Acidity and Alkalinity (pH), Chloride, Atmospheric temperature by use of various thermometer, BOD, COD, DO, Ec, Turbidity, TDS. Study of Productivity.	12	36
2.	Identification and study of Larvae of Marine Invertebrates and Vertebrates.	08	24
3.	Identification and classification of marine fauna from protozoa to mammals.	12	36
4.	Isolation of Bacteria from marine sediments and water sample	04	12
5.	Identification and classification of Marine Algae.	05	15
6.	Qualitative study of marine habitat. And grain size analysis.	08	24
7.	Identification & Classification of corals and coral reef by preserved specimen and charts.	05	15
8.	Identification of Mangrove	03	09
9.	Preparation of agar gel from seaweed	05	15
10.	Preparation of alginate from seaweed	05	15
11.	Preparation of Carrageenan from seaweed.	05	15
12.	Study of Bathymetry map.	03	09
13.	Recognition of contour maps, dome, basis, ridge.	03	09
14.	Analysis of size, roundness and spherically by visual comparison charts and Identification of Minerals.	03	09
15.	Collection, identification and preservation of Benthos	03	09
16.	Study of pigments of phytoplankton.	03	09
17.	Collection, identification and preservation of plankton (qualitative and quantitative).	03	09

M.Sc. Marine Biology
Semester: II
Paper No: 5

Title of the Paper: **Biochemistry, Genetics and Molecular biology**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Chemistry of the Gene: Structure of DNA, nucleic acid as genetic material, types of DNA and RNA and their function. Replication of DNA. Central Dogma of Molecular biology. RNA directed DNA synthesis, (reverse transcription). Purification of DNA, Method of introducing gene into host-cell-vector	16	18
Unit 2	Genetic Code, Wobbles Hypothesis, Ribozymes. Gene expression and regulation. Mutation, Mutagen, Mutagenesis and Detection of Mutation. Mechanism of DNA damage and repair. Enzymes used for DNA manipulation, vectors for cloning, hybridization techniques, and gene library, DNA applications.	16	18
Unit 3	Structure, classification and function of proteins, carbohydrates, fats and vitamins. Metabolism: Energy yielding processes. Photosynthesis, respiration and mineral metabolism.	14	17
Unit 4	Mendel's law of inheritance, modification of Mendelian inheritance (Neo Mendelism), Extra nuclear and extra-chromosomal inheritance; Gene interaction; Linkage, sex-linked genes and lethal genes. Formation of new races and species.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Conn, FE, & Stump, PK, *Outlines of Biochemistry*, Wiley Eastern, LTD, (1989).
2. Lehninger, Nelson, & Cox, *Principles of Biochemistry* (2nd ed.) CBS Publ. (1993).
3. Trehan, K, *Biochemistry*, Wiley Eastern LTD. (1990).
4. De Robertis, Cell and Molecular Biology, Lea & Febiger USA, (1988).
5. King, B, *Cell Biology,* Allen & Unwin, (1986).
6. Stent, GS, & Calender, R, *Molecular Generics*, WH Freeman & Co USA, (1978).
7. Gupta, PK, *Genetics,* Rastogi Publ. Meerut, (1997).
8. Ignacimutthu, *Basic Biotechnology*, Tata Mc Grew Hill, (1995).
9. Kumar, HD, *A Text Book of Biotechnology*, East West, New Delhi (1994).
10. Gupta, PK, *Elements of Biotechnology,* Rastogi & Co,. Meerut, (1994).
11. Mitra, S, *Genetic Engineering*, Mac millan (1990).

M.Sc. Marine Biology
Semester : II
Paper No: 6

Title of the Paper: **Instrumentation, Biostatistics and Research Methodology**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Measures of variability or Dispersion: Range, mean deviation, standard deviation, variation. Basic probability theory and application. Statistical hypothesis and its testing. Correlation and Regression. Non-parametric statistical tests: Wilcoxon Rank Sum test, Mann-Whitney test, etc.	16	18
Unit 2	Biostatistics: Introduction and history, methods of collection of biological data, organization, classification and representation of data. Frequency distribution. Measures of central tendency. Student t-test, Chi-square test, ANOVA.	16	18
Unit 3	Instrumentation: Types of water and sediment samplers: Nelson water sampler, Grab sampler, etc. Sacchi discs. Microscopy, chromatography Colorimetry, Flame photometry, spectrophotometry and spectroscopy.	14	17
Unit 4	Research and Experimental design. Scientific deliveries and communication: writing research proposal, paper, thesis, report. Presenting scientific research: power point presentation, posters, flyers, etc. Publication processes, review processes and significance of scientific communication.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Christian, GD, & O'Reilly, *Instrumental Analysis*, (2nd ed.) Alhyn & Bacon, (1986).
2. Skoog, DA, & Leary, JJ, *Principles of Instrumental Analyses* Saunders, (1992).
3. Rajaram, V, *Computer programming in fortran*, Prentice Hall, (1983).
4. Zar, J, *Biostatistics,* Prentice Hall, (1984).
5. Arora, PN, *Biostatistics*, Prabhat Book Centre, Gwaliar, (1989).
6. Bailey, NTJ, *Statistics methods in Biology*, Cambridge Univ., Press (Low price edition), (1994).
7. Gupta, GB, *Introduction to Statistica*l Methods, (7th ed.) oliver & Boyd. (1975).
8. Ghan, IA & Khanum, A. *Fundamentals of Biostatistics*, Vkaaz. Publ. Hyderabad, (1995).
9. Lewis, A. Biostatistics. East West Press, New Delhi. (1971).
10. Chatterjee, S.and Price, B. Regression Analysis by Examples, John Wiley, New York. (1977).
11. Sharma, S. and Bansal, A. Research Methodology. IB Publication, New Delhi. (2009).

M.Sc. Marine Biology
Semester : II
Paper No: 7

Title of the Paper: **Conservation & Management of Marine Biota and Eco-Tourism.**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Marine Tourism in India and other countries, marine protected areas of India, Famous Beaches of India, Eco-tourism and recreational tourism, marine Amusement parks and their impact on Tourism.	16	18
Unit 2	Conservation biology: Status of endangered marine fauna and their conservation , Keystone species, Ecology vs. Economy, Bioethics & Conservation, Causes of extinction, IUCN Red Data Book, International agreements, Man and Biosphere program.	16	18
Unit 3	Marine Birds: Distribution and types, Economic Importance. Marine Reptiles: Distribution, types and status, Economic Importance. Marine Mammals: Mammals adaptation for marine life, distribution and Economic Importance.	14	17
Unit 4	Fauna and Flora of the islands of the worlds. Their Classification, distribution and Conservation. Economic and ecological Importance.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. John E. Reynolds, Biology of Marine Mammals (2001)
2. Gunther, A. A Guide to Reptiles & Fishes Daya Publication, New Delhi (2001)
3. Nicol, JAC The Biology of Marine Animals Pitman(2002)
4. James L. Sumich, John F. Marrisey Introduction to the Biology of Marine life
5. Kartik Shanker, B C Choudhury Marine Turtles of the Indian Subcontinent University Press.
6. Gorman, M. L. Island Ecology. Chapman and Hall Ltd. London. (1979).

M.Sc. Marine Biology
Semester : II
Paper No: 8

Title of the Paper: **Practical**
Credits: 18 Marks: 100 Marks
Marks: Semester End Examination: 100 Marks

Sr. No	Practical	No. of Practical	Hrs. required
01	Biochemistry: Analysis of phytopigments from marine algae.	05	15
02	Estimation of DNA, RNA	04	12
03	Estimation of Protein, reducing sugar, Amino acid, carbohydrates etc.,	08	24
04	Preparation various models of amino acids and carbohydrates by Ball & Stick models.	05	15
05	Study of various genetics exercise from text books	06	18
06	Study of various instruments used in laboratory e.g. Laminar flow, conductivity meter, colorimeter, Nephalon Turbidometry (NTU), etc.	08	24
07	Principle and methodology of flame photometer, spectrophotometer, Spectroscopy (NMR and mass atomic absorption.)	06	18
08	Chromatography	04	12
09	Use of Water Sampler, GPS and Grab sampler.	04	12
10	Diagrammatic representation of Data- Histogram, Frequency Polygon, Frequency Curve, Ogive curve, bar chart, Pie diagram.	04	12
11	Measures of Central tendency and dispersion.	04	12
12	Correlation and Regression Analysis.	03	09
13	t Test- testing single mean and difference of two means using (1) Independent samples and (2) Paired Samples.	04	12
14	Chi-square test (1) Goodness of fit test (2) Testing Independence of two attributes (characters).	05	15
15	One way Analysis of Variance.	04	12
16	Two way Analysis of Variance.	03	09
17	Wilcoxon's and Mann- Whitney U test.	03	09
18	Identification of Sediment samples with special reference to texture and composition under microscope.	03	09
19	Operation of Current meter	03	09
20	Measurements of evaporation, transpiration and relative humidity.	04	12

M.Sc. Marine Biology
Semester: III
Paper No: 9

Title of the Paper: **Aquaculture**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Sewage fed Fisheries, brackish water fish culture and live feed culture, Culture and management of ornamental fish for aquarium.	16	18
Unit 2	Establishment and management of culture pond. Harvest techniques, Establishment and Maintenance of marine aquarium.	16	18
Unit 3	Culture / Cultivation of commercially important marine algae and study of their products	14	17
Unit 4	Culture / Cultivation of commercially important marine animals. Control measures/management of disease in aquaculture	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Bardch, JE, et al, *Aqua Culture*, John Wiley, Interscience, (1972).
2. Fast, AW & Lester, GJ, *Marine Shrimp Culture*: Principles and Practices, (1992).
3. Srivastaval et al., (eds.), *Brackish Water Aqua Culture Development in India*, Concept Publ. Co. New Delhi, (1987).
4. Denila, L. (1976). Layout design, construction and levelling of fish ponds. Eadings on pond construction and management, Tigbauan, Iloilo, Philippines.
5. Jamandro, T. J. and Rabanal, H. R. (1975). Engineering aspects of brackish water aquaculture in the South Chaina Sea Region. SCS/75/WP/16.
6. Wheaton, F. W. (1987). Aquaculture Engineering. Robert E. Krieger Publ. Florida.

M.Sc. Marine Biology
Semester : III
Paper No: 10

Title of the Paper: **Fishery Science**
Credits: 4 Marks: 100 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	General morphology and anatomy of fish and shellfish. Growth & age study of fishes, Fecundity, survival & mortality of fishes.	16	18
Unit 2	Estuarine fisheries recourses of India. Fish population, Distribution and Migration of fish.	16	18
Unit 3	Economically important marine fishes & shellfishes and their marketing. Fishing community and their socio economic problems.	14	17
Unit 4	Fishing crafts and gears. Methods of fish detection in the sea (VHF, GPS, Fish finder, etc).	14	17

Marks: Semester End Examination: 70 Marks

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Bal, DV & Rao, KV, *Marine Fisheries* (2nd ed,) Tata Mc Graw Hill, New Delhi, (1989).
2. Cushing, DH, *Marine Ecology and Fisheries*, Cambridge Univ., Press. (1975).
3. Cushing, D, *Fisheries Resources of the sea and their Management*, E.L.B.S. Low Priced ed., (1975)
4. Santhanam, R, *Fisheries Science*, K. K. Fine Arts Press, Delhi, (1990)
5. Jhingran, V.G., *fish and fisheries of India* (3rd ed.), Hindustan Publishing Co., New Delhi, (1991).
6. Das & Das, *fish and Prawn Diseases in India*, Fish Soc., of India, Barrack Port, West Bengal, (1997).
7. Amlacher, E. *Text Book of Fish Diseases* Narendra Publishing House, New Delhi.
8. Anderson, D.P., *Text Book of Fish Immunology* Narendra Publishing House, New Delhi.
9. Biswas K.P, *Fish, Fisheries and Technology*, Narendra Publishing House, New Delhi.
10. Ninawe / Diwan, *Women Empowerment in Fisheries* Narendra Publishing House, New Delhi.
11. Sinha V.R.P. *Fisheries Research Planning and Management in Developing Countries*, Narendra Publishing House, New Delhi.
12. Biswas K.P., *Prevention and Control of Fish and Prawn Diseases 2nd ed*. Narendra Publishing House, New Delhi.
13. Sundaraj, V. Cultivable Aquatic Organism, Narendra Publishing House, New Delhi.

M.Sc. Marine Biology
Semester : III
Paper No: 11

Title of the Paper: **Processing & preservation technology of fish and its products.**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Fundamentals of Biochemistry & Microbiology of fishes. Spoilage of fish & fish products: Causes and sterilization methods. (TPC, E.coli, Salmonella test). Quality assurance of seafood and HACCP.	16	18
Unit 2	Edible fish products: Fish ham, Sausage and other fish paste products, Surimi. Importance of fish meat, fish oils, etc. Transgenic Fishes.	16	18
Unit 3	Non edible fish and shellfish products: Fish essence and isinglass, skin, bone and teeth, collagen, glue, etc	14	17
Unit 4	Post-harvest technology of fish and fish products. Handling of fishes. Preservation technologies: Curing (Drying, salting & smoking), Freezing and canning technology. Fermented products and Marinades.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. A.L.Winton, and Winton K.B., 2000 *Fish & fish products* Agrobios, New Delhi.
2. Biswas K.P, *Fish, Fisheries and Technology*, Narendra Publishing House, New Delhi.
3. C.L.Cutting, *Fish Processing and Preservation*, Agro Botanical Publishers, Bikaner.
4. Bhattnagar, S. and Shammi Q.J., (2002) *Applied Fisheries* Agrobios Jodhpur.

M.Sc. Marine Biology
Semester : III
Paper No: 12

Title of the Paper: **Practical**
Credits: 18 Marks: 100 Marks

Sr. No	Practical	No. of Practical	Hrs. required
1.	Anatomy of cartilaginous and bony fish	13	39
2.	Anatomy of prawn/lobster.	06	18
3.	Anatomy of Sepia/Loligo/Octopus.	06	18
4.	Identification of fish	03	09
5.	Study of various fish products	02	06
6.	Age determination from scales, hard parts and otoliths.	01	03
7.	Study of various fishing crafts & gear.	02	06
8.	Observation of organoleptic characteristics of given fishes	01	03
9.	Quality assessment of traditional sun dried and solar tent dried fish by organoleptic, bacteriological and chemical methods.	01	03
10.	Preparation of Shark lever oil	02	06
11.	Preparation of fish fillet, fish paste, FPC (Fish protein concentrate), fish meal, etc..	02	06
12.	Preparation of Chitin & Chitosan	02	06
13.	Study of chemical composition of fish like moisture, lipid, ash, protein and non-protein, etc.	02	06
14.	Technique of fish salting and determination of salt concentration with time interval.	03	09
15.	Estimation of fecundity and gut contents in fishes.	02	06
16.	TPC, E-coli and Salmonella test of fish	02	06
17.	Estimation of Ca, MG, Cl and So4 from seawater, salt and brine water.	10	30
18.	Study of maturation stages of gonads in different size of fishes	01	03
19.	Study of viral, bacterial and fungal pathogens from permanent slide.	03	09
20.	Hydrobiology of Aquaculture pond	02	06
21.	One day fishing in trawler boat with well-equipped navigation equipment / Instruments	02	06
22.	Visit to aquaculture farm	03	09
23.	Visit to fish processing industry	07	21
24.	Visit to fisher folk to know their problems	01	03
25.	Isolation and identification of microorganisms from spoiled fishery products	01	03
26.	Analysis of fatty acid, triglyceride, galactolipid and phospholipid of mangrove leaves, sea grasses and sea weeds.	02	06
27.	Quantitative estimation of protein, carbohydrate and lipid in some marine and estuarine fin-fishes and shell-fishes.	02	06
28.	Identification of eggs, larvae, fry and fingerlings of marine and estuarine fin-fishes and shell-fishes.	02	06
29.	Study of fish and prawn dieses from charts and photograph.	01	03
30.	Identification of larval stages of fish and shellfish of commercially important.	01	03
31.	Collection and preservation of seaweeds and halophytes.	02	06

M.Sc. Marine Biology
Semester : IV
Paper No : 13

Title of the Paper: **Marine pollution, Ocean management and effect of Climate change.**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Major marine pollutants: sewage, industry effluents, agricultural discharges, shrimp farm discharges, oil pollution, thermal and radioactive pollution. Solid dumping, effects of mining and dredging operation. CPCB and GPCB standards, Marine bio-deterioration.	16	18
Unit 2	Aquatic toxicology: toxicological concept & principles, factors that influence toxicity, toxic agents & their effects, toxicity testing & interpretation of test data, Marine Biofouling: Micro and macro-fouling, fouling organism & their control.	16	18
Unit 3	Ocean management: Technology strategy in ocean management, development of international principles. Ocean management in India.	14	17
Unit 4	Climate change and sea-level rise, Global impacts of Sea-level rise, Management strategies to counter sea-level rise, Regional experience of sea-level rise	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Banerji, SK, *Environmental Chemistry*, Prentice Hall, (1993).
2. Geyer, RA, *Marine Environmental Pollution* Vol. I & II, Elsevier, (1981).
3. Johnson, R, *Marine Pollution*, Academic Press, (1976).
4. Ram Prakash & Sood, PP, *Toxicity and Monitoring of xenobiotics,* Venus Publ. Co,. New Delhi, (1995).
5. Rhodes et al, *The Use of Saline Waters for Crop Production* FAO Published by Scientific Publishers, Jodhput, (1994).
6. Sethi et al, *Environmental Pollution,* Commonwealth Publ. New Delhi, (1991).
7. Sharma, SK & Gupta, IC, *Saline Environmental and Plant* Growth, Agro-Botanical Publishers, Bikaner, (1986).
8. Kapoor, R. Ocean Management. Book Enclave, Jaipur. 2009.

M.Sc. Marine Biology
Semester : IV
Paper No: 14

Title of the Paper: **Coastal Regulation Zone, various Coastal resources and Remote Sensing**

Credits: 4 Marks: 100 Marks

Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Coastal Regulation Zone, Integrated Coastal Zone Management and EEZ. Coastal processes: formation of coast line and erosion, Marine resources: Minerals, marine energy and food resources.	16	18
Unit 2	Construction and management of Salt pan, salt production methods. Salt industries in national economic scenario, Marine resources: Drinking water technology.	16	18
Unit 3	Satellite oceanography: Introduction, principles of satellite remote sensing, Digital image processing, GIS concept and application in coastal system, GIS relate to Indian Coastal water	14	17
Unit 4	Use of remote sensing systems in detection, utilization and management of various marine resources: Phytoplankton blooms, Primary production, Fisheries, Habitat in shallow tropical seas, Shelf seas, Estuaries and coasts.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Timothy Beatley, David J. Brower, Anna K. Schwab.—2nd ed. An introduction to coastal zone management. ISLAND PRESS. 2002.
2. Barnes, RSK, *The Coastal line*, John Wiley, (1977).
3. Coastanza, R, *Ecological Economics*: The Science and Management of Sustainability, Columbia Univ., Press, NY, (1991).
4. May RM, *Exploitation of Marine Communities*, Springer Verlag, (1984).
   Crachnel.
5. A. P. Remote sensing application in Marine Biology and Technology. D. Reidel Publishing C. (1982).
6. Robinson, I.S. Discovering the Ocean from space- The Unique Applications of Satellite Oceanography. Springer Heidelberg Dordrecht London New York.(2010).
7. Xiaojun Yang (Ed.). Remote Sensing and Geospatial Technologies for Coastal Ecosystem Assessment and Management. Springer-Verlag Berlin Heidelberg. 2009.
8. Ahana Lakshmi, Aurofilio Schiavina, Probir Banerjee, Ajit Reddy, Sunaina Mandeen, Sudarshan Rodriguez and Deepak Apte "The Challenged Coast of India", A report prepared by PondyCAN in collaboration with BNHS and TISS. October 2012.
9. Woodroffe, C. D. Coasts: Form, Process and Evolution. Cambridge University Press, New York. 2002.
10. Davidson-Arnott. R. An Introduction to Coastal Processes and Geomorphology. Cambridge University Press, New York. 2010.

M.Sc. Marine Biology
Semester : IV
Paper No: 15

Title of the Paper: **Environmental monitoring and Marine biotechnology**
Credits: 4 Marks: 100 Marks
Marks: Semester End Examination: 70 Marks
Continuous Internal Evaluation: 30 Marks

Unit	Detailed Syllabus	Teaching hrs.	Marks/ Weight
Unit 1	Environmental protection Act-1986, Wildlife protection Act-1972, Water (prevention & control of pollution) Act-1974, Gujarat Fisheries Act, Coastal Aquaculture Authority Act, Biodiversity Act, Environmental Auditing.	16	18
Unit 2	Environmental education: background, goals, objectives and principles. Environmental education in India. Fund raising protocols & grant writing process for environmental issues. Environmental organizations and agencies, Environmental Impact Assessment: general process & documentation.	16	18
Unit 3	Introduction to marine biotechnology: tools, research area & scope and applications. Marine drugs and pharmaceuticals.	14	17
Unit 4	Environmental applications of marine biotechnology: Bioremediation, spilled oil bioremediation, use of bioremediation in wetlands. Biotechnology for Marine Environment restoration.	14	17

Break up of Continuous Internal Evaluation:

1. Test 15 Marks
2. Assignment/Presentation 10 Marks
3. Seminar/Attendance 05 Marks

Total Marks: 30 Marks

Reference/Text-Books/Additional Reading:

1. Sharma, P.D. Ecology and Environment. Rastogi Publication.
2. Kulkarni, V. and Ramchandran, TV. Environmental Management. Teri Press. 2006.
3. Anjaneyula and Manickam, V. Environmental Impact Assessment Mythologies. Taylor and Francis. 2011.
4. Odum, EP. Environment, Power and Society. Willey Intersicence, New York. 1983.
5. Kirubakaran, S. Environmental Education. Sarup and Sons Pub. 2007.
6. Thakur, K. Environmental Protection law and policy in India. Deep and Deep Pub. ltd. 2007.
7. Pathak, H. A Handbook of Environment Protection Act. Creatspace Independent Pub. 2013.
8. Frances, H. Global Environmental Issues. Willey Pub. 2012.
9. Ignacimutthu, Basic Biotechnology, Tata Mc Grew Hill, (1995).
10. Kumar, HD, A Text Book of Biotechnology, East West, New Delhi (1994).
11. Gupta, PK, Elements of Biotechnology, Rastogi & Co,. Meerut, (1994).
12. Mitra, S, Genetic Engineering, Mac millan (1990).

M.Sc. Marine Biology
Semester : IV
Paper No: 16

Title of the Paper: **Practical (50 Marks) + Dissertation (50 marks)**
Credits: 18 Marks: 100 Marks

Sr. No	Practical	No. of Practical	Hrs. required
01	Beach profile survey and sediment sample collection.	07	21
02	To measure the common pollutants in water samples.	06	18
03	To perform toxicity test of chemicals and metals on fish.	08	24
04	To measure biodiversity at coastal zone by quadrate methods(Simpson formula)	07	21
05	Analysis of sediment samples.	15	45
06	Biochemical identification of unknown bacteria	05	15
07	Microbial population enumeration techniques.	05	15
08	Analysis and estimation of critical pollutants in seawater, sediment and marine organism.	07	21
09	Identification and classification of microorganisms from the litters of mangroves.	05	15
10	Report of study tour/ field trips	06	18
11	Field observation on marine fauna and flora regarding the effect of pollution.(Hydro biological analysis)	05	15
12	Assessment of coastal erosion	05	15
13	Habitat mapping by using GIS technology and various instruments	05	15
14	Assessment of solid waste on coastal area	04	12

Dissertation (50 Marks) in lieu of Practical

- Dissertation/Project commences in III semester but evaluated and grade point are to be added in 4th semester. Educational Tours/ Field works may be carried out in any semester or all semesters, but evaluated and Grade points are to be added in 4th Semester only.

LIST OF COURSES PROPOSED TO BE OFFERED AS CHOICE BASED INTER DISCIPLINARY COURSES TO THE REGULAR STUDENTS REGISTERED IN OTHER PG DEPARTMENTS

(w.e.f. Academic Year commencing from July 2018)

For the interdisciplinary subjects the minimum requisites are given bellow for the students who want to study the papers of Marine Biology. A test may be conducted to find suitability of applicant for a particular course, by the department/competent authority, before admitting in that course.

Faculty: **Science**
Subject: **Marine Biology**
PG Department: **Department of Marine Science**

Sr. No.	Semester	Course Title	Eligibility	Remarks
1	1	Ecology	1. The candidate should admitted in the PG department of science faculty in Bhavnagar University. 2. B.Sc. Degree with Marine science/ zoology/ botany/ microbiology/ biotechnology/ fisheries/ forestry/environmental science/agriculture/veterinary science or any of the subject mentioned above should be studied as subsidiary subject during second year B.Sc.	
2	1	Oceanography	1. The candidate should admitted in the PG department of science faculty in Bhavnagar University. 2. B.Sc. Degree with Marine science/ physics/ chemistry/ zoology/ botany/ microbiology/ biotechnology/fisheries/forestry/ environmental science /agriculture/veterinary science etc.	
3	2	Biochemistry, Genetics and Molecular biology	1. The candidate should admitted in the PG department of science faculty in Bhavnagar University. 2. B.Sc. Degree with Marine science/ zoology/ botany/ microbiology/ biotechnology/ fisheries/ forestry/environmental science/agriculture/veterinary science etc.	
4	2	Instrumentation, Biostatistics and Research Methodology	1. The candidate should admitted in the PG department of science faculty in Bhavnagar University. 2. B.Sc. Degree with any science subject.	